REPORT No. 236

TESTS ON AIRPLANE FUSELAGES, FLOATS AND HULLS

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SUMMARY

This report is a compilation of test data on airplane fuselages, nacelles, airship cars, seaplane floats, and seaplane hulls, prepared by the Bureau of Aeronautics, at the request of the National Advisory Committee for Aeronautics. The discussion of the data includes the derivation of a scale correction curve to be used in obtaining the full scale drag. Composite curves of drag and L/D for floats and hulls are also given.

INTRODUCTION

In order to make an accurate estimate of the probable performance of an airplane, the parasite drag must be known. When wind tunnel test data are not available, this parasite drag must be obtained by some process of summation, and in such a process one of the largest and most uncertain items is the drag of the fuselage, or similar parts, such as the nacelles, hull, or floats. The usual practice is to compare the desired design with other and similar designs for which test data are available.

In 1922 the Bureau of Aeronautics compiled all of the wind tunnel test data then available on fuselages, hulls, nacelles, and floats, into a form which was convenient for ready reference. This compilation was of such value that the National Advisory Committee for Aeronautics has seen fit to request its release for publication as the first of a series of reports, giving wind tunnel test data of this type in condensed form.

For convenience in reference the models have been divided into seven groups, each designated by a letter as follows:

A.—Airplane fuselages.
B.—Airplane fuselages with appendages.
C.—Nacelles.
D.—Fins.
E.—Airship cars.
F.—Seaplane floats.
G.—Seaplane hulls.

Each model is designated by a group letter and a number, thus A1, i. e., airplane fuselage No. 1, or F4, float No. 4.

TEST DATA

For each model the source of the test data, the size of the model, and the test speed are given in addition to the test data. Whenever practical, the drag is given in pounds and pounds per square foot at some specified wind speed.

The data from British tests are frequently in the form of normal force Z and longitudinal force X. When necessary these can be converted to lift and drag by the usual formulas:

$$L = Z \cos \theta - X \sin \theta \qquad (1)$$

$$D = X \cos \theta + Z \sin \theta$$

Where θ is the angle of pitch.

Corrections for pressure drop along the wind tunnel axis have not been applied to any of the test data in this report. Since it would rarely be more than the experimental error, the omission of this correction is apparently justified for all models which deviate appreciably from the conventional streamline forms. For example, on the float F1 the maximum possible correction for pressure drop at 58.7 f. p. s. is about 0.0007 pound, while the actual correction is somewhat less, due to location of model during tests. Since the measured drag of F1 at 58.7 f. p. s. was 0.0627 pound, the correction would be of the order of 1 per cent.

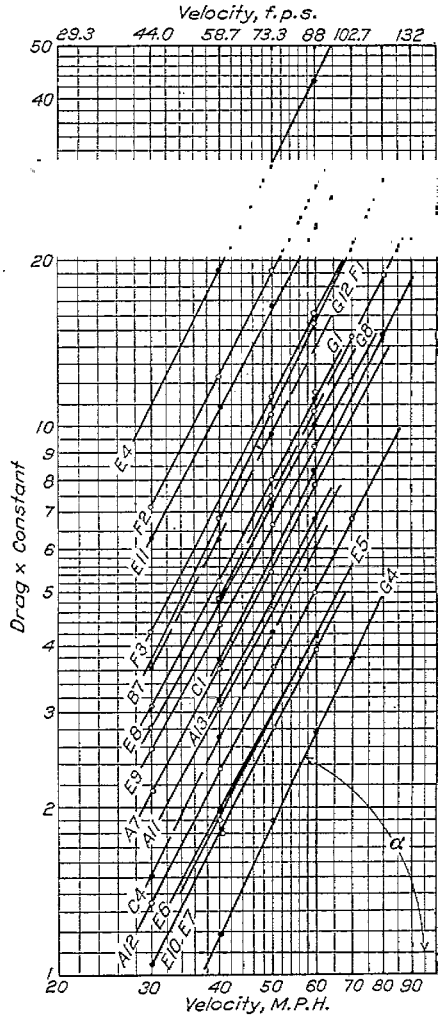


FIG. 1

SCALE EFFECT

Taking the product of the velocity V by some characteristic length l as the "scale" the lift may be assumed to vary as the square of the scale. That is:

$$L = K_L (Vl)^2 \tag{3}$$

where K_L is a constant for each model.

The drag does not vary as the square, but as some lesser power of the scale. Figure 1 is a logarithmic plot or drag against speed for all models tested at more than one speed. The slopes of the lines with the corresponding exponents are given in the following table:

VELOCITY EXPONENT IN THE DRAG EQUATION
$D = KV^n$

Model designation	α	$\frac{n}{\tan \alpha}$
A7	61.7	1.86
A11	61.3	1.86
A12	62.2	1.90
A13	61.6	1.85
B7	63.7	2.02
C1	62.7	1.94
C4	63.0	1.96
E4	63.0	1.96
E5	61.0	1.80
E6	61.8	1.86
E7	62.3	1.90
E8	61.8	1.86
E9	61.4	1.91
E10	62.3	1.90
E11	61.8	1.86
F1	62.7	1.94
F2	62.3	1.90
F3	62.4	1.91
G1	61.8	1.86
G4	64.0	2.05
G8	61.2	1.82
G11	62.5	1.92
G12	62.7	1.94
Average	62.2	1.90

The average value of the exponent so found is $n = 1.90$. While this strictly applies to the velocity only, it may be assumed for variation in length also. The drag equation may therefore be written as

$$D = K_D (Vl)^{1.9} \tag{4}$$

where K_D is a constant for each model.

It will probably be found more convenient to use instead of equation (4):

$$D = K_s D_m \left(\frac{V l}{V_m l_m}\right)^2 \tag{5}$$

where K_s is the scale correction factor given on Figure 2, D_m the observed model drag at $V_m l_m$ and D the full scale drag at Vl.

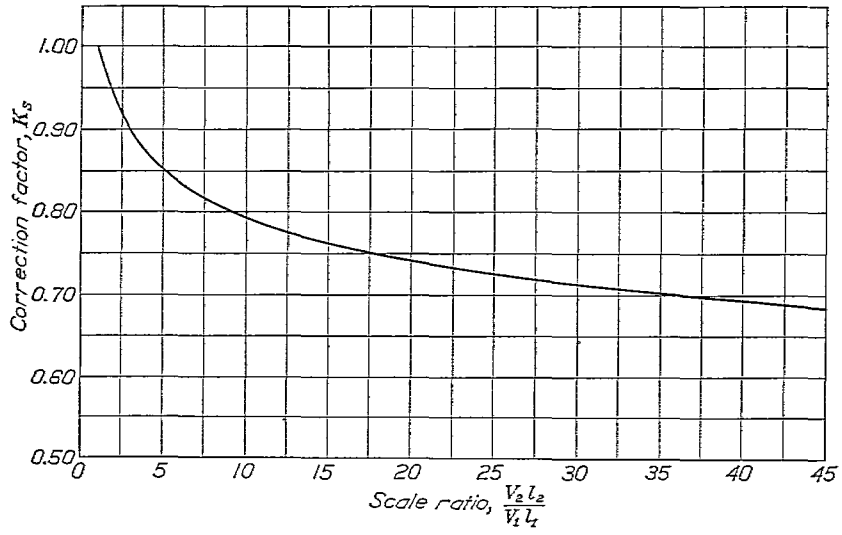


FIG. 2.—Drag correction factors for fuselages, hulls, floats, etc. Based on the assumption that $D \propto V^{1.90}$
$D_2 = K_s D_1 \left(\frac{V_2 l_2}{V_1 l_1}\right)^2$ Where D_1 = Drag at $V_1 l_1$ and D_2 = Drag at $V_2 l_2$

In converting model data to full scale values, any length on the model such as maximum diameter, overall length, etc., may be used to determine the scale, provided that the same geometrical length is used for model and full scale. The use of overall length is recommended, however.

The square of a length has the dimensions of area so that the maximum cross-sectional area may be used instead of l^2 if desired.

COMPOSITE CURVES FOR FLOATS AND HULLS

The drag curves for different floats and hulls differ so little, one from another, that a composite curve may be drawn to represent within comparatively narrow limits the drag for all

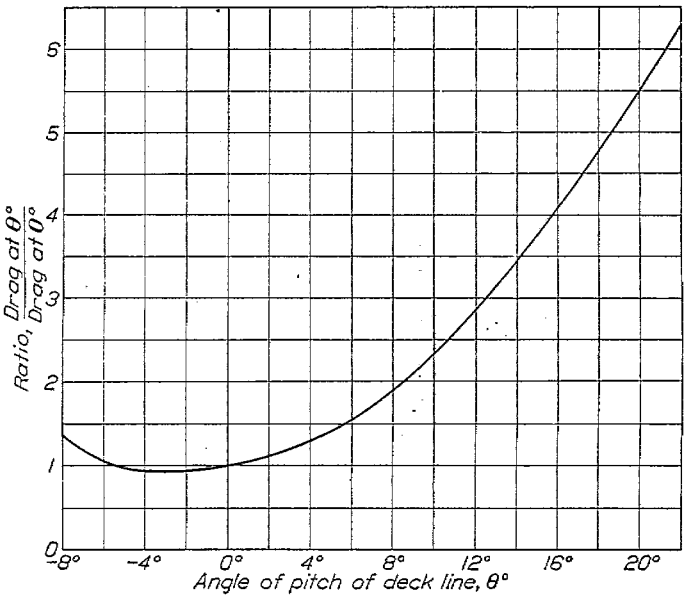


FIG. 3.—Composite resistance curve for seaplane floats and hulls

such models. This curve is given on Figure 3. Knowing the drag for 0° pitch of the deck line, the drag for any normal pitch angle is readily obtained from this curve.

The lift curves are also similar, so that a composite curve for L/D may be drawn as in Figure 4.

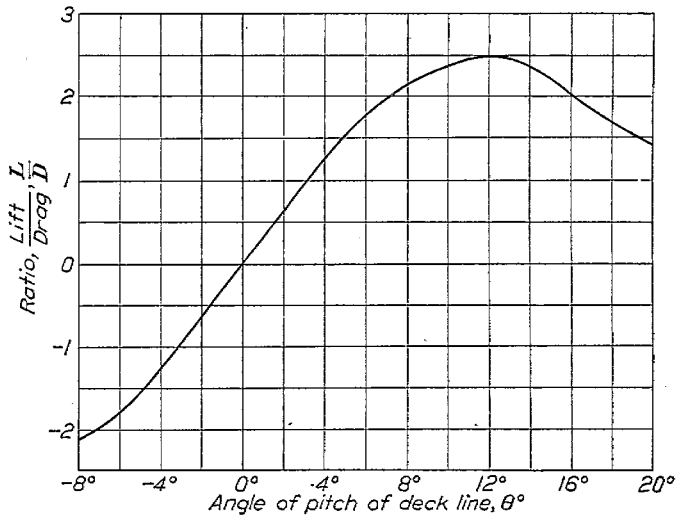
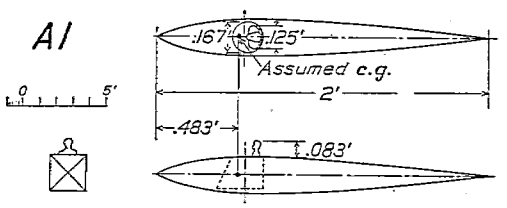
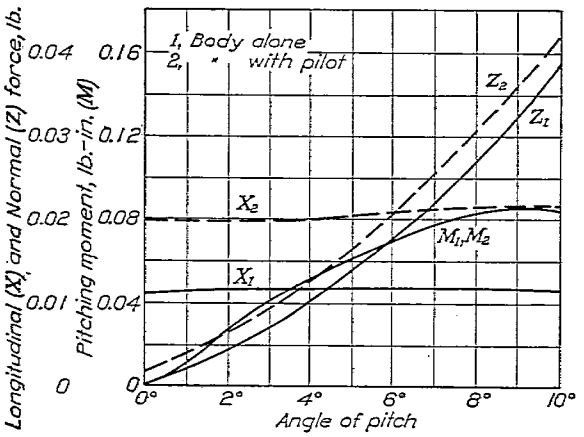


FIG. 4.—Composite L/D curve for floats and hulls

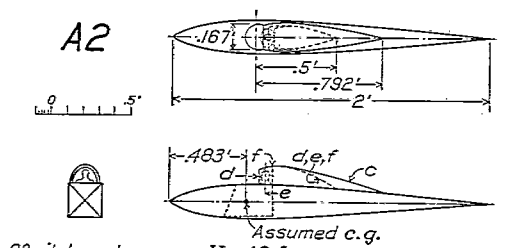
The curves of Figures 3 and 4 apply to any form which approximates to a streamline and which does not have too many appendages. From the limited data available there is reason to believe that the same, or at any rate similar, curves will apply to all body lines of the average or better types.



1	0° pitch and yaw		S = .0455 sq. ft.		
	V, f.p.s.	40	2	V, f.p.s.	40
	D, lb.	.0114		D, lb.	.0197
	D/S, lb./sq.ft.	.2505		D/S, lb./sq.ft.	.4330

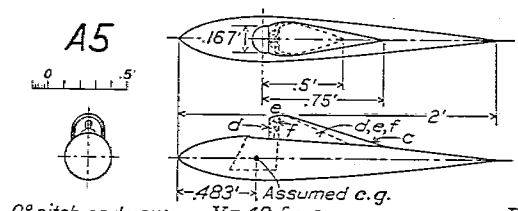


Forces and moments in pitch on an airplane fuselage. V=40 f. p. s. (Ref. R. and M. No. 112)



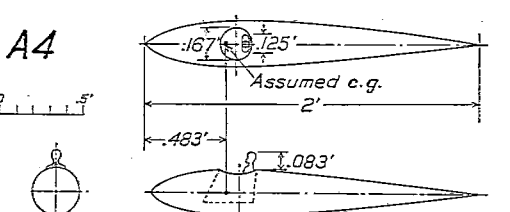
0° pitch and yaw	V = 40 f.p.s.	D, lb.
a, Model without wind shield or pilot		.0114
b, " with pilot, no wind shield		.0197
c, " " long wind shield aft		.0254
d, " " short " "		.0257
e, " " " " "	", front cut back to e	.0217
f, " " " " "	", " " " " f	.0265

Drag on an airplane fuselage. V=40 f. p. s. (Ref. R. and M. No. 112)

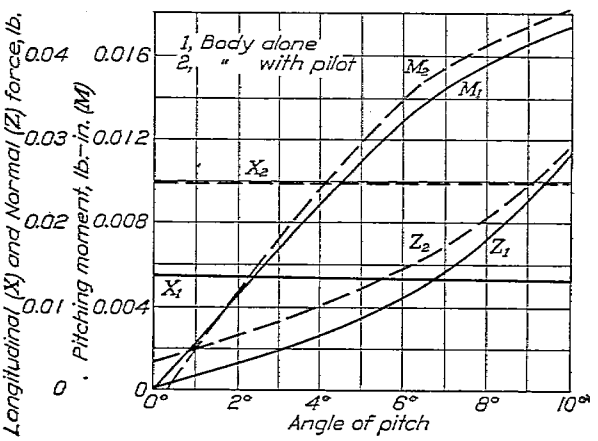


0° pitch and yaw	V = 40 f.p.s.	D, lb.
a, Model without wind shield or pilot		.0134
b, " with pilot, no wind shield		.0246
c, " " long wind shield aft		.0256
d, " " " " "		.0252
e, " " " " "	", front cut back to e	.0272
f, " " " " "	", " " " " f	.0296

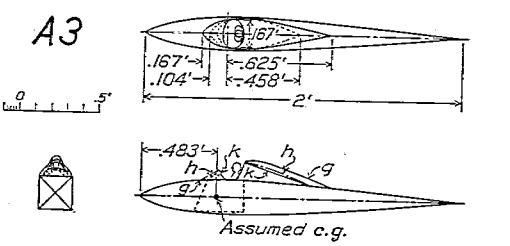
Drag on airplane fuselage. V=40 f. p. s. (Ref. R. and M. No. 112)



1	0° pitch and yaw		S = .0640 sq. ft.		
	V, f.p.s.	40	2	V, f.p.s.	40
	D, lb.	.0134		D, lb.	.0236
	D/S, lb./sq.ft.	.2094		D/S, lb./sq.ft.	.3688

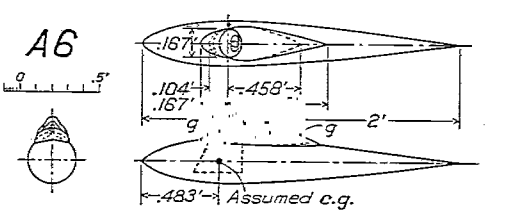


Forces and moments in pitch on an airplane fuselage V=40 f. p. s. (Ref. R. and M. No. 112)



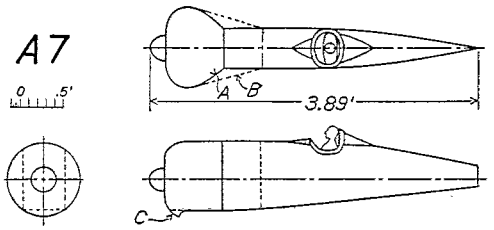
0° pitch and yaw	V = 40 f.p.s.	D, lb.
a, Model without wind shield or pilot		.0114
b, " with pilot, no wind shield		.0197
g, " " wind shield "g-g"		.0206
h, " " " "h-h"		.0242
k, " " " "k-k"		.0336

Drag on an airplane fuselage. V=40 f. p. s. (Ref. R. and M. No. 112)



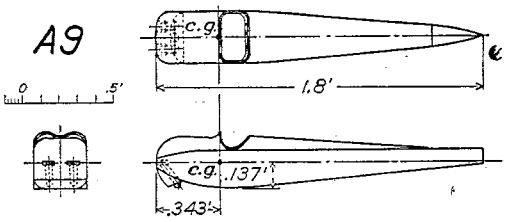
0° pitch and yaw	V = 40 f.p.s.	D, lb.
a, Model without wind shield or pilot		.0134
b, " with pilot, no wind shield		.0246
g, " " wind shield "g-g"		.0225
h, " " " "h-h"		.0242
k, " " " "k-k"		.0272

Drag on airplane fuselage. V=40 f. p. s. (Ref. R. and M. No. 112)



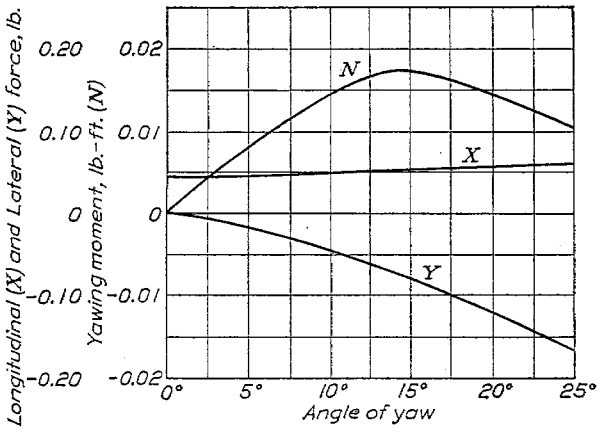
0° pitch and yaw					
	V, f.p.s.	44.0	58.7	73.3	88.0
Original model "A"	D, lb.	.2850	.4750	.7280	1.0150
S=.6750 sq.ft.	D/S, lb./sq.ft.	.4222	.7037	1.0785	1.5037
Fairing "B" added	D, lb.	.2150	.3630	.5460	.7830
S=.6750 sq.ft.	D/S, lb./sq.ft.	.3185	.5378	.8089	1.1600
Fairing "C" removed	D, lb.	.2000	.3420	.5250	.7450
S=.6620 sq.ft.	D/S, lb./sq.ft.	.3021	.5166	.7931	1.1254

Drag on a Navy speed scout seaplane fuselage. (Ref. W. T. R. No. 20)

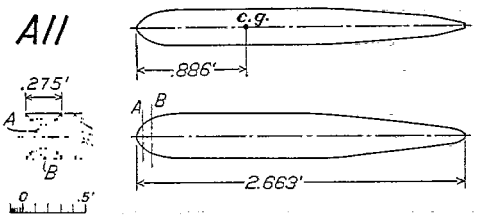


0° pitch and yaw S=.0870 sq.ft.

V, f.p.s.	40
D, lb.	.0443
D/S, lb./sq.ft.	.5100



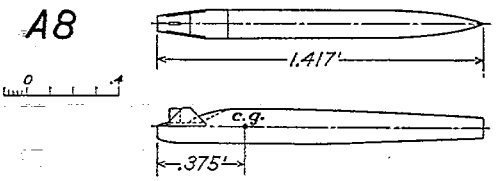
Forces and moments in yaw on fuselage of Sopwith biplane-type D^a. 0° pitch. V=40 f. p. s. (Ref. R. and M. No. 153)



0° pitch and yaw S=.1012 sq.ft.

V, f.p.s.	35	40	50
D, lb.	.0256	.0304	.0466
D/S, lb./sq.ft.	.2530	.3004	.4605

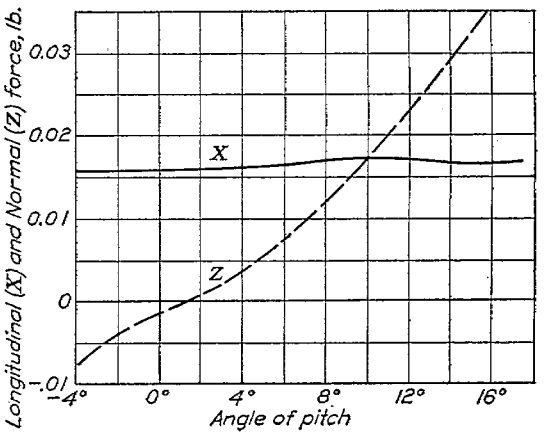
Drag on an airplane fuselage, Bristol Pullman (B). (Ref R. and M. No. 644)



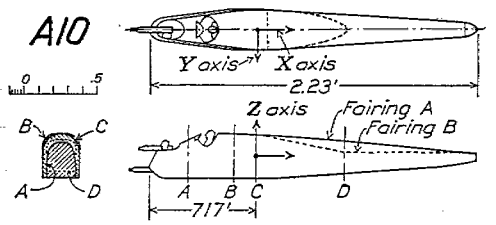
S=.0173 sq.ft.

0° pitch and yaw

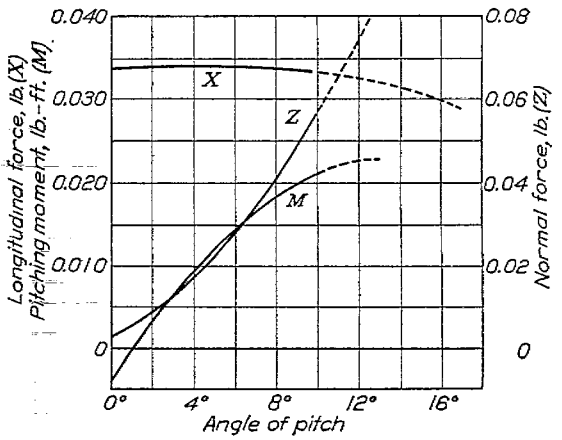
V, f.p.s.	40
D, lb.	.0159
D/S, lb./sq.ft.	.9200



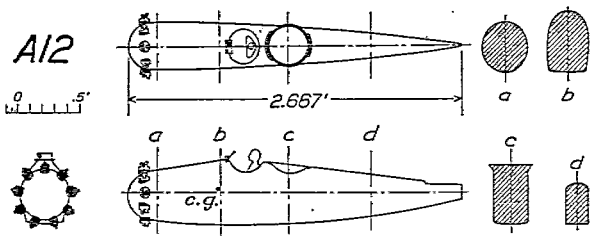
Forces and drag on model-seaplane fuselage. (Ref. R. and M No. 199)



0° pitch and yaw		S=.0780 sq.ft.	
V, f.p.s.	40	V, f.p.s.	40
	Fairing "A"		Fairing "B"
D, lb.	.0331	D, lb.	.0340
D/S, lb./sq.ft.	.4250	D/S, lb./sq.ft.	.4360



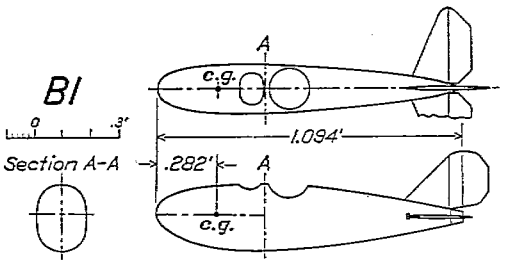
Forces and moments in pitch on airplane fuselage F-E-7 model with fairing "A". V=40 f. p. s. (Ref. R. and M. No. 153)



0° pitch and yaw V = 40 f.p.s. D = .0384 lb.
1, Body without eng., pilot or wind shield, all holes faired - - - -
2, (1) with pilot in place - - - - - - - - - - - - - - D = .0484 lb.
3, (2) " wind shield in place - - - - - - - - - - - D = .0609 lb.
4, Complete as shown, with engine - - - - - - - - D = .1540 lb.

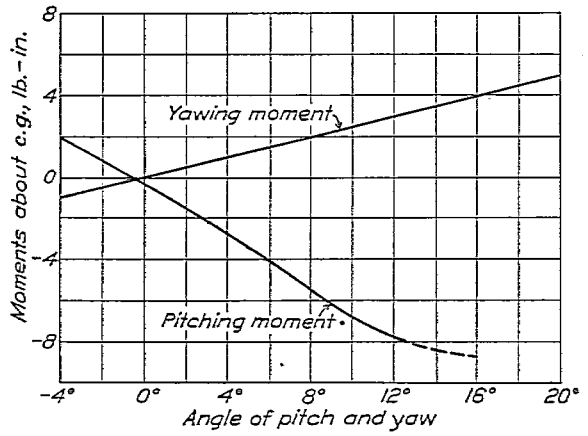
	V, f.p.s. - - -	44.0	58.7	73.3	88.0	102.7
Combination 1	D, lb. - - - -	.136	.237	.365	.500	.680
" 2	D/S, lb./sq.ft.	.442	.783	1.200	1.718	2.235

Drag on "Weasel" airplane fuselage. (Ref. R. and M. No. 465)

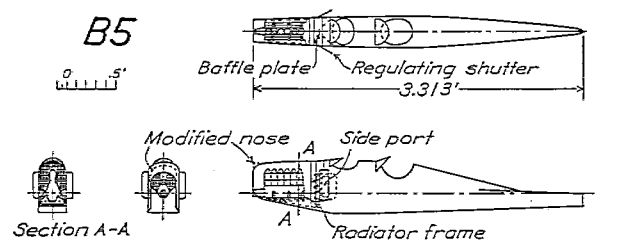


−2° pitch S = .0506 sq.ft.

V, f.p.s.	58.7	88.0
D, lb.	.0123	.0330
D/S, lb./sq.ft.	.2430	.6522

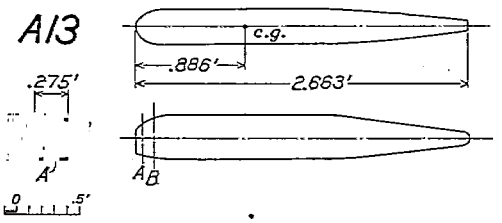


Moments about c. g. of Kirkham triplane-speed-scout fuselage. V = 58.7 f. p. s. (Ref. W. T. R. No. 73)



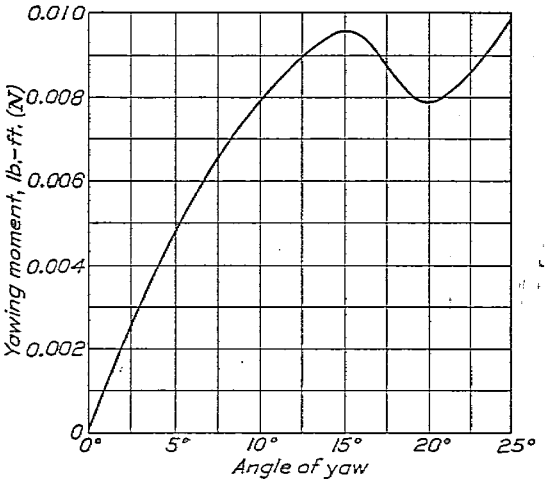
(A) Original model
All openings closed, D = .1157 lb.
Side ports (only) closed, D = .1226 lb.
Inlet opening closed: shutter, 12° D = .1316 lb. " " 25° D = .1698 lb.
(B) Modified model (square nose) D = .1508 lb.
Side ports open, shutters removed, D = .1630 lb.
$D = KSV^2$, K = .00075, S = sq.ft., V = f.p.s.

Drag on fuselage of RE-7 airplane with shutters. V = 40 f. p. s. (Ref. R. and M. No. 221)

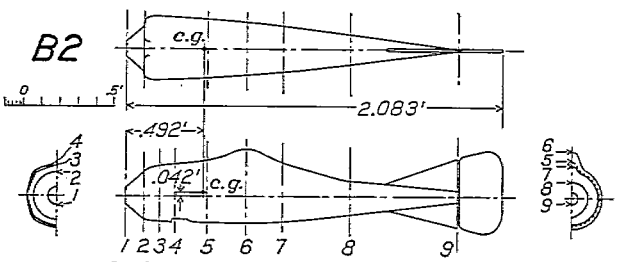


0° pitch and yaw S = .1012 sq.ft.

V, f.p.s.	35	40	50
D lb.	.0276	.0315	.0482
D/S, lb./sq.ft.	.2727	.3113	.4763

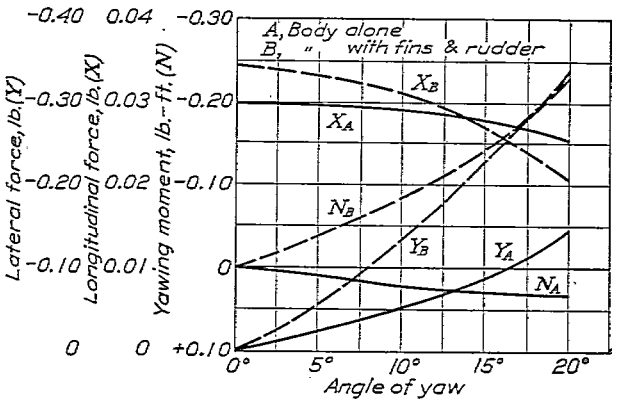


Yawing moment about c. g. of airplane fuselage of Bristol Pullman (A). V = 50 f. p. s. (Ref. R. and M. No. 644)

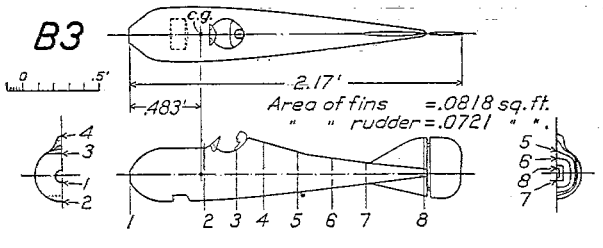


0° pitch and yaw S = .1280 sq.ft.

A	V, f.p.s.	40	B	V, f.p.s. 40
	D, lb.	.0296		D, lb. .0343
	D/S, lb./sq.ft.	.2313		D/S, lb./sq.ft. .2680

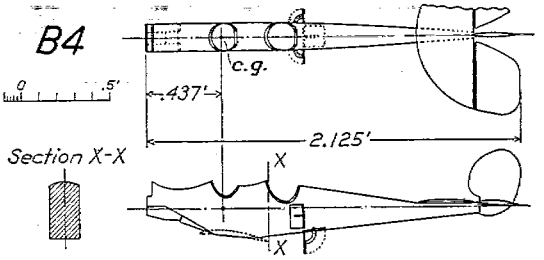


Forces and moment in yaw on fuselage of SE-4 airplane. V = 40 f. p. s. (Ref. R. and M. No. 112)



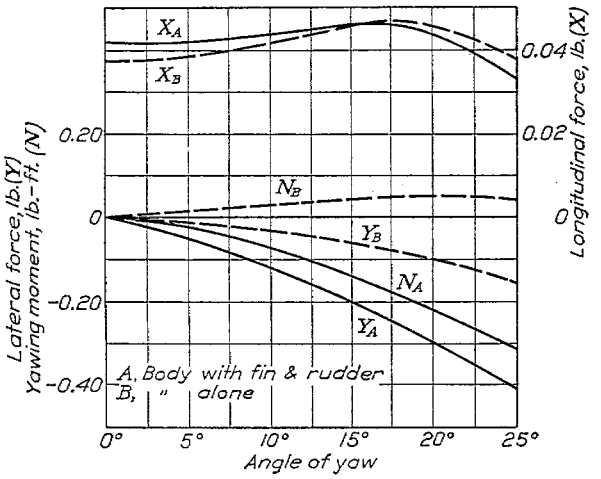
0° pitch and yaw V = 40 f.p.s. S = .1032 sq.ft.

Body with fin and rudder		Body alone	
D, lb.	.0417	D, lb.	.0378
D/S, lb./sq.ft.	.4041	D/S, lb./sq.ft.	.3663

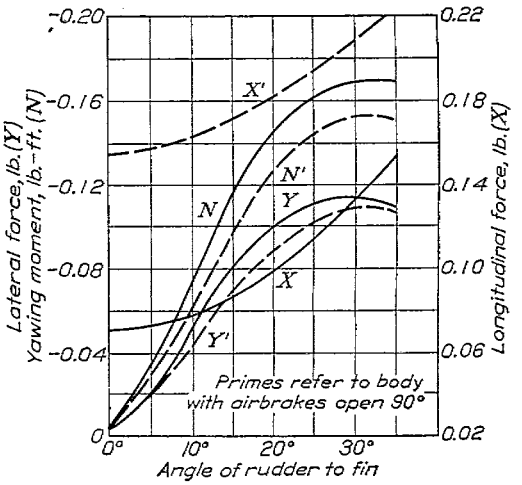


0° pitch and yaw V = 40 f.p.s. S = .0510 sq.ft.

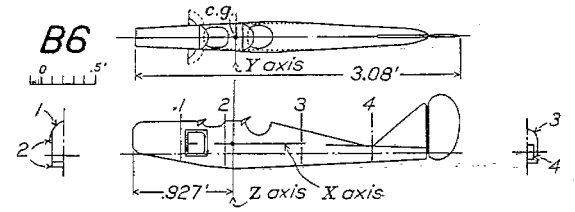
Airbrakes closed		Airbrakes open 90°	
D, lb.	.0696	D, lb.	.1550
D/S, lb./sq.ft.	1.3647	D/S, lb./sq.ft.	3.0392



Forces and moments on fuselage of SE-4a airplane. V=40 f. p. s. (Ref. R. and M. No. 153)

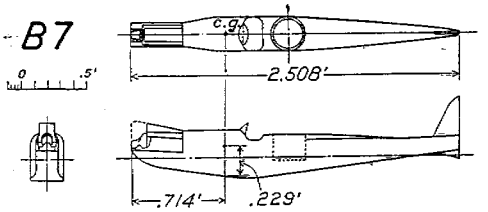


Effect of airbrakes on rudder of RE-1 airplane 0° pitch and yaw V=40 f. p. s. (Ref. R. and M. 112)



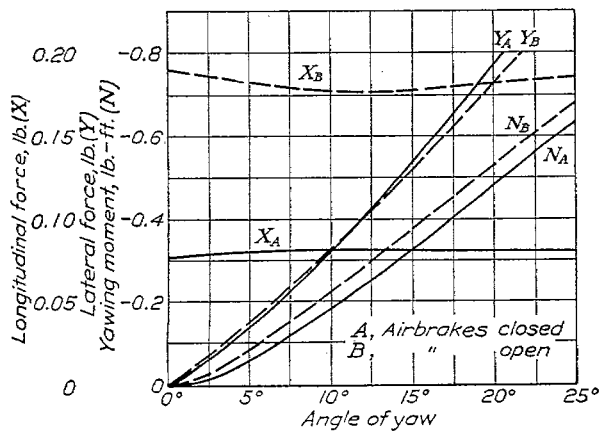
S_f = .110 sq. ft. (fin) S_r = .160 sq. ft. (rudder) S = .0928 sq. ft.
0° pitch and yaw V, 40 f.p.s. With brakes, S = .1578 sq. ft.

Rudder neutral: Airbrakes closed.		Rudder neutral: Airbrakes open.		Without fin & rudder: Airbrakes closed.	
D, lb.	.0753	D, lb.	.1882	D, lb.	.0697
D/S, lb./sq.ft.	.8114	D/S, lb./sq.ft.	1.193	D/S, lb./sq.ft.	.7511

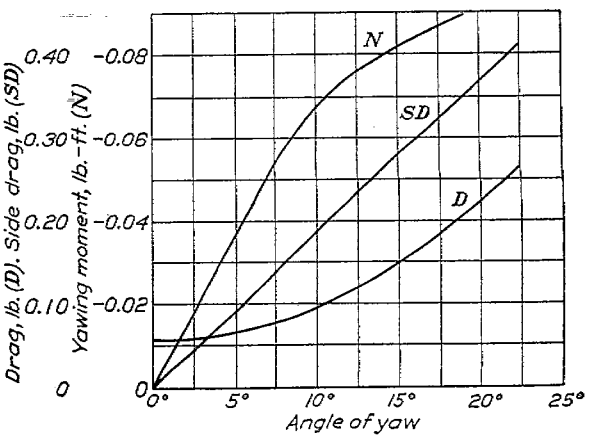


0° pitch and yaw. Body without fins. S = .0913 sq. ft.

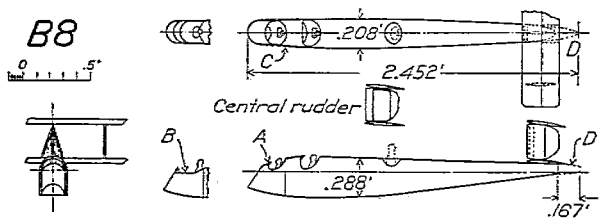
V, f.p.s.	40	50	60	70
D, lb.	.0685	.1060	.1540	.2150
D/S, lb./sq.ft.	.7503	1.1610	1.6867	2.3549



Forces and moments in yaw on RE-7 airplane fuselage fitted with airbrakes. V=40 f. p. s. (Ref. R. and M. No. 153)

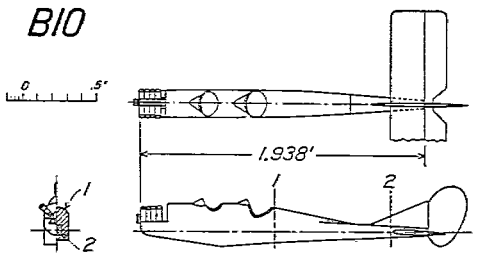


Forces and moments in yaw on RE-8 airplane fuselage with fins shown. V=40 f. p. s. (Ref. R. and M. No. 201)



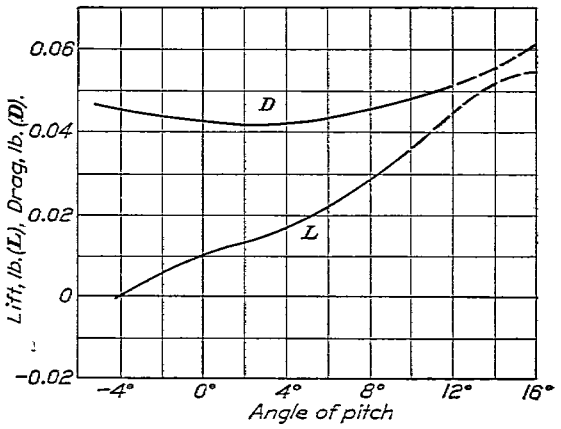
0° pitch and yaw V = 40 f.p.s. S = .0560 sq. ft.
Model as shown "A" - - - - - - - D = .0730 lb., D/S = 1.3036 lb./sq.ft.
1, Body without stabilizers - - D = .0294 lb., D/S = .5250 lb./sq.ft.
2, With cockpit "B" - - - - - - - D = .0314 lb., D/S = .5607 lb./sq.ft.
3, (1) With fairing "C" - - - - - D = .0263 lb., D/S = .4696 lb./sq.ft.
4, (1) " man in open cockpit D = .0394 lb., D/S = .7036 lb./sq.ft.
5, (1) 3rd cockpit faired over D = .0296 lb., D/S = .4804 lb./sq.ft.
6, (1) With fairing "D" added - - D = .0265 lb., D/S = .4732 lb./sq.ft.
Area of fixed fin = .0667 sq.ft. Area of central rudder = .035 sq.ft.
" " outer rudders = .0425 sq.ft. Total fin area = .1442 sq.ft.

Drag on fuselage of FE-4 airplane. 0° pitch and yaw V = 40 f. p. s. (Ref. R. and M. No. 221)

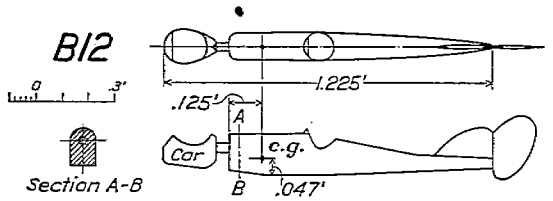


Complete model V = 40 f.p.s. S = .0520 sq.ft.

Angle of pitch	-2°	+3°	+8°	+13°
D, lb.	.0850	.0650	.0710	.1120
D/S, lb./sq.ft.	1.6346	1.2500	1.3654	2.1538



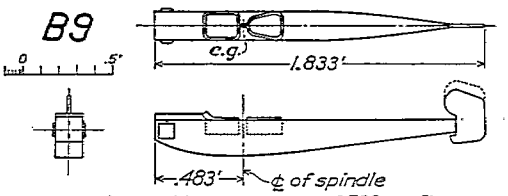
Lift and drag on fuselage only of BE-2c airplane. (Ref. R. and M. No. 254)



0° pitch and yaw V = 40 f.p.s. S = .0935 sq.ft.

Without car	D, lb.	.0275	With car D, lb. .0352
	D/S, lb./sq.ft.	.2941	With car D/S, lb./sq.ft. .3765

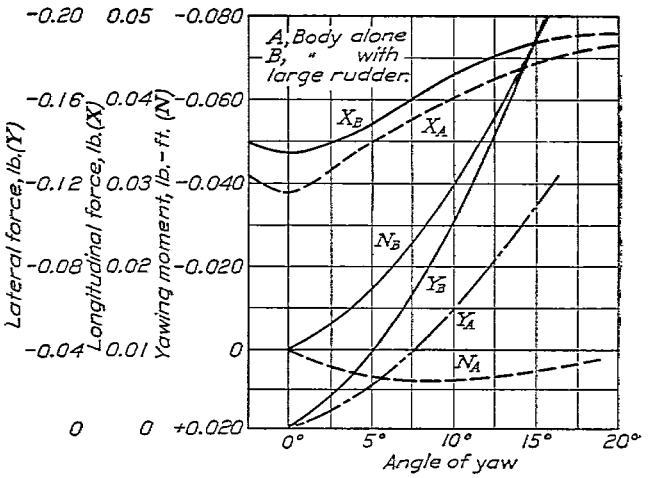
Drag with faired car on body of BE-9 airplane. (Ref. R. and M. No. 202)



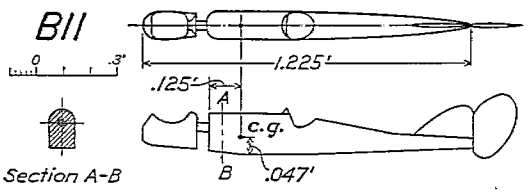
Area of large rudder = .0598 sq.ft.
" " small " = .0458 " ".

0° pitch and yaw S = .0390 sq.ft.

With large rudder		Body alone	
V, f.p.s.	40	V, f.p.s.	40
D, lb.	.0332	D, lb.	.0287
D/S, lb./sq.ft.	.8513	D/S, lb./sq.ft.	.7359

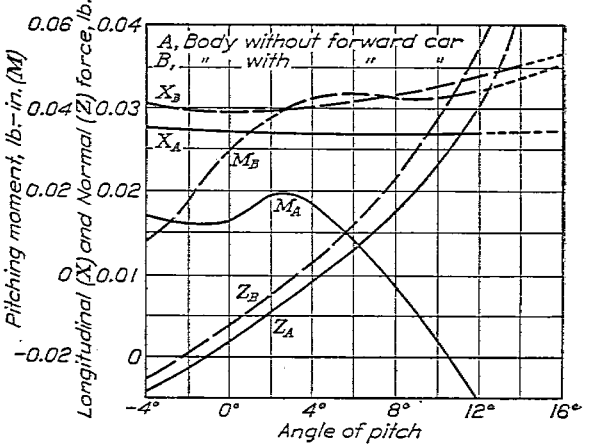


Forces and moments in yaw on fuselage of Avro seaplane. V = 40 f. p. s. (Ref. R. and M. No. 156)



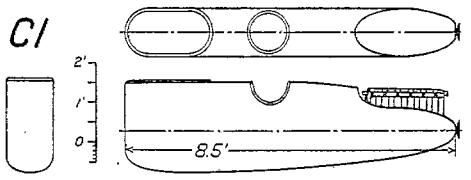
0° pitch and yaw V = 40 f.p.s. S = .0935 sq.ft.

Without forward car		With forward car	
D, lb.	.0275	D, lb.	.0296
D/S, lb./sq.ft.	.2941	D/S, lb./sq.ft.	.3166



Forces and moments in pitch with unfaired car on fuselage of BE-9 airplane. V = 40 f. p. s. (Ref. R. and M. No. 202)

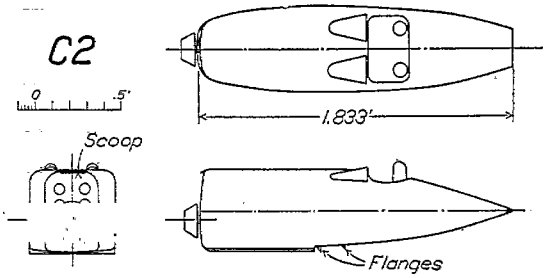
C1



0° pitch and yaw			S = 2.60 sq. ft.	
V, f.p.s.	58.7	88.0	117.3	146.6
D, lb.	3.7800	8.3500	14.7000	22.7000
D/S, lb./sq.ft.	1.4538	3.2115	5.6538	8.7308

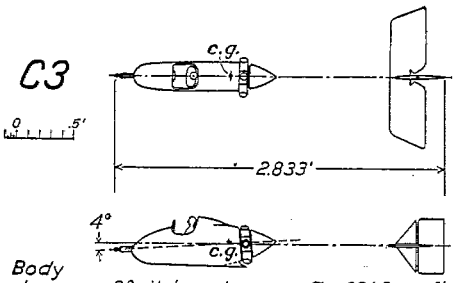
Drag on nacelle of Davis-gun seaplane. (Ref. W. T. R. No. 67)

C2

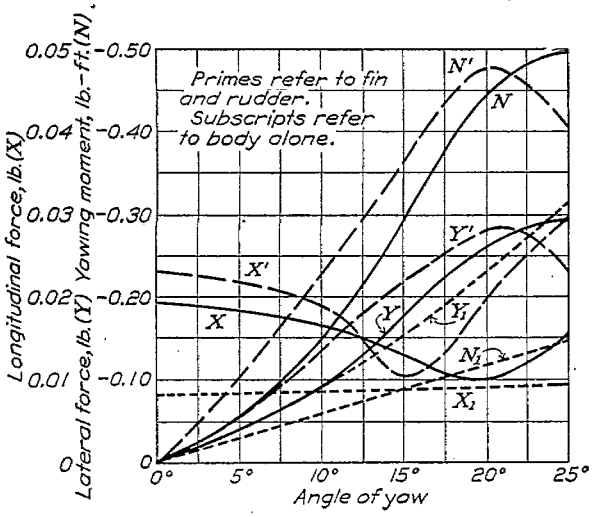


0° pitch and yaw S = .258 sq. ft.
V = 58.7 f.p.s. D = .1883 lb D/S = .7298 lb./sq.ft.

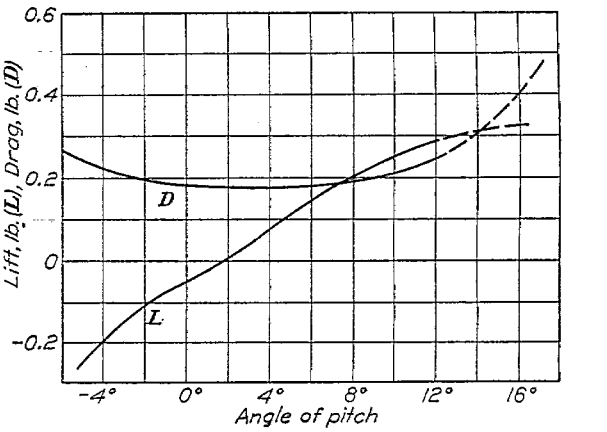
C3



Body alone 0° pitch and yaw S = .0910 sq. ft. (approx.)
V = 40 f.p.s. D = .0848 lb D/S = .9319 lb./sq.ft.

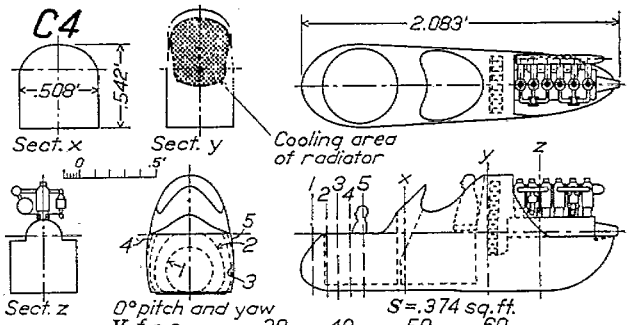


Forces and moments of fin and rudder. FE-8 airplane nacelle. V=40 f. p. s. (Ref. R. and M. No. 156)



Lift and drag on nacelle of Richardson seaplane. V=58.7 f. p. s. (Ref. W. T. R. No. 54)

C4

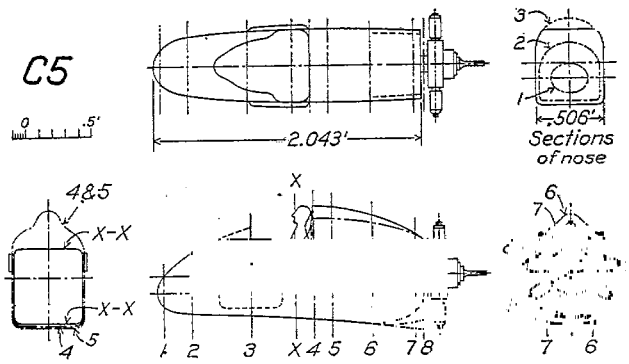


0° pitch and yaw S = .374 sq. ft.

V, f.p.s.	30	40	50	60
D, lb.	.1520	.2710	.4250	.6060
D/S, lb./sq.ft.	.4060	.7240	1.1360	1.6200

Drag on nacelle of FE-2b airplane. (Ref. R. and M. No. 305)

C5

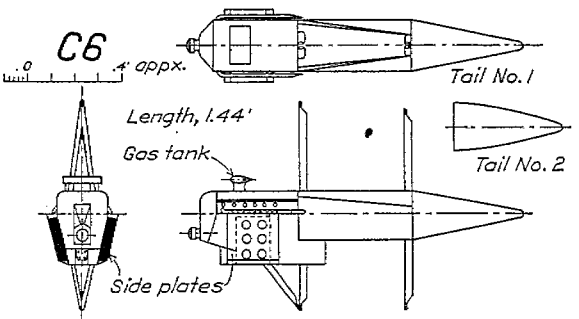


0° pitch and yaw S = .4180 sq. ft.

V, f.p.s.	30	40	50	60
D, lb.	.1250	.2180	.3410	.4900
D/S, lb./sq.ft.	.2990	.5220	.8150	1.1700

Drag on nacelle of FE-8 airplane. (Ref. R. and M. No. 305)

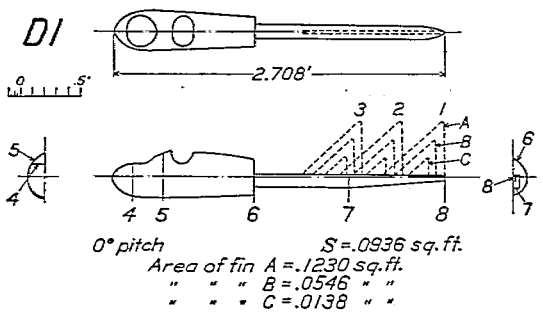
C6

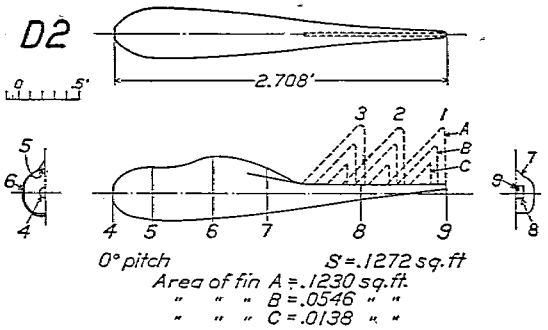


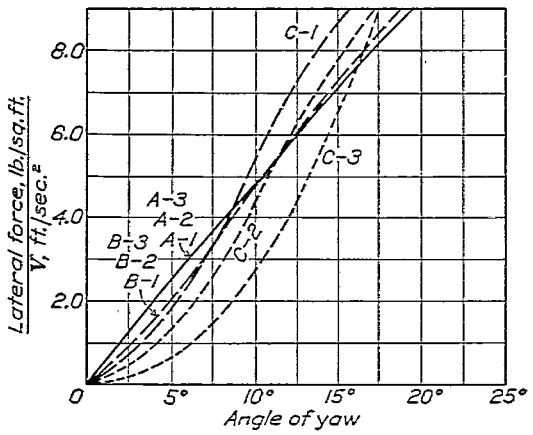
0° pitch and yaw V = 40.0 f.p.s.

No. 1 tail with radiators,	D = .1120 lb.,	without,	D = .0865 lb.
No. 2 " " "	D = .1151 lb.,	"	D = .0874 lb.
Without tail, " "	D = .1210 lb.,	"	D = .1088 lb.
Drag due to, side plates,	D = .0103 lb.,	gas tank,	D = .0072 lb.

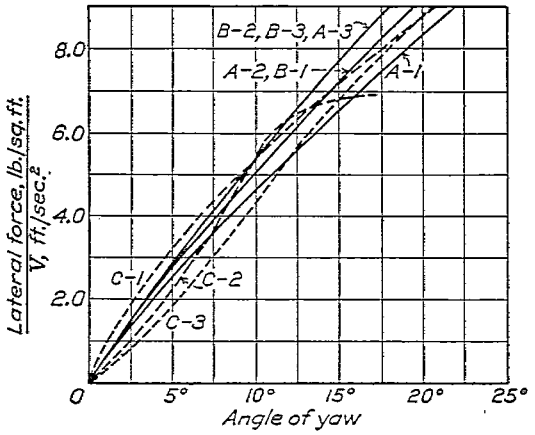
Drag on nacelle of Handley Page airplane. (Ref. R. and M. No. 251)



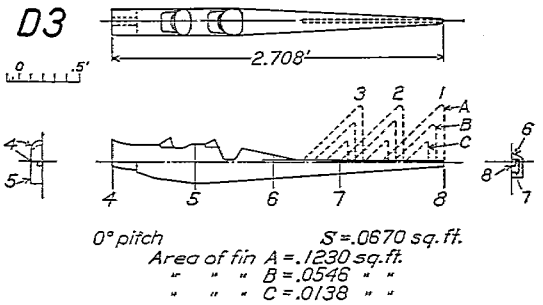


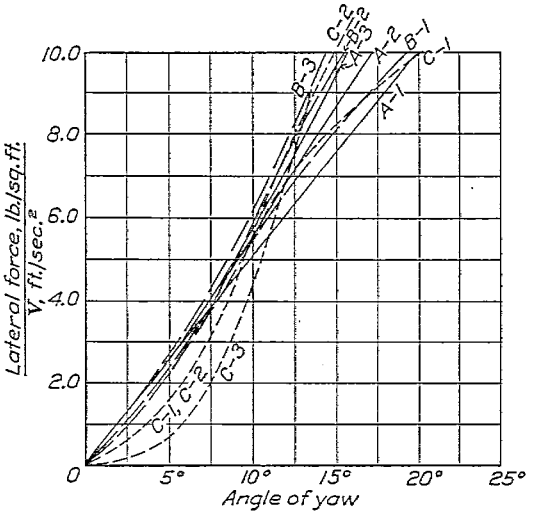


Lateral force on fin only of FE type fuselage. (Ref. R. and M. No. 201)

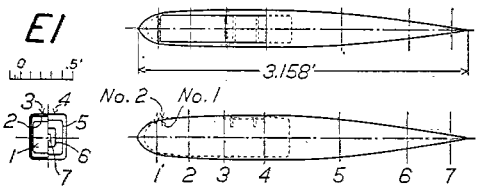


Lateral force on fin only of SE type fuselage. (Ref. R. and M. No. 201)

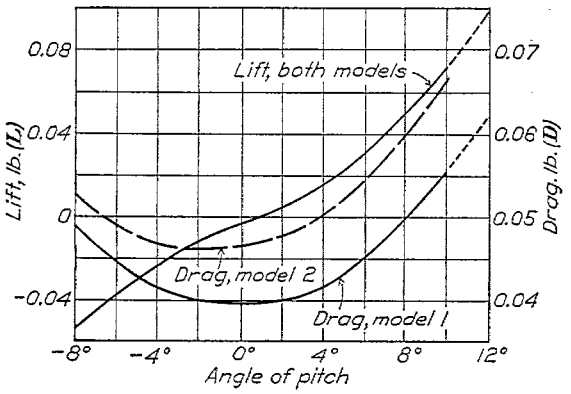




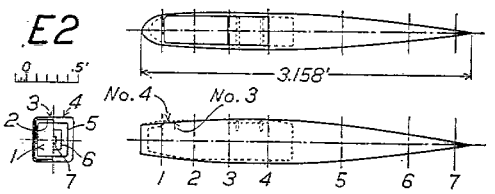
Lateral force on fin only of RE or Be type fuselage. (Ref. R. and M. No. 201)



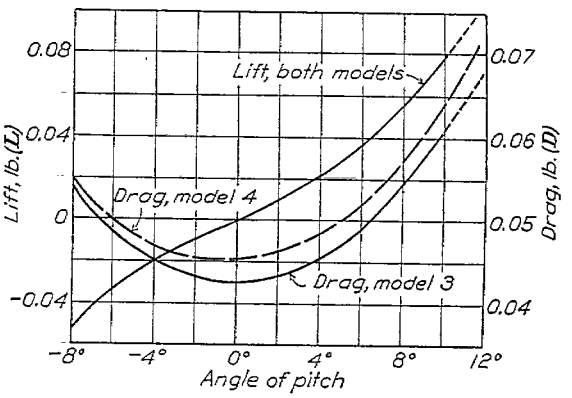
	Model No. 1	Model No. 2
V, f.p.s.	40	40
D, lb.	.0395	.0471
D/S, lb./sq.ft.	.2582	.3078



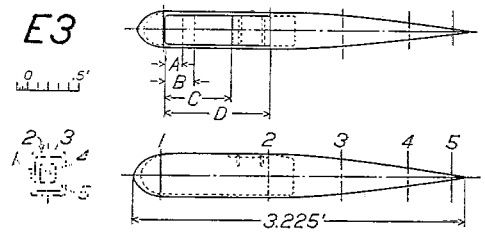
Lift and drag on H. M. A. "Epsilon" airship car, models Nos. 1 and 2



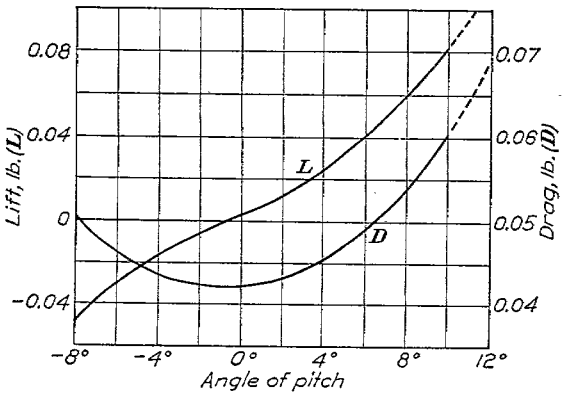
	Model No. 3	Model No. 4
V, f.p.s.	40	40
D, lb.	.0426	.0455
D/S, lb./sq.ft.	.2784	.2974



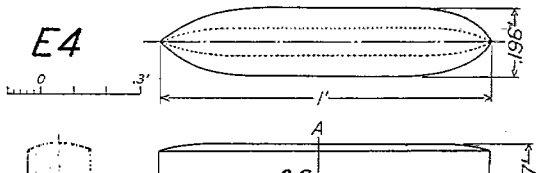
Lift and drag on H. M. A. "Epsilon" airship car, models Nos. 3 and



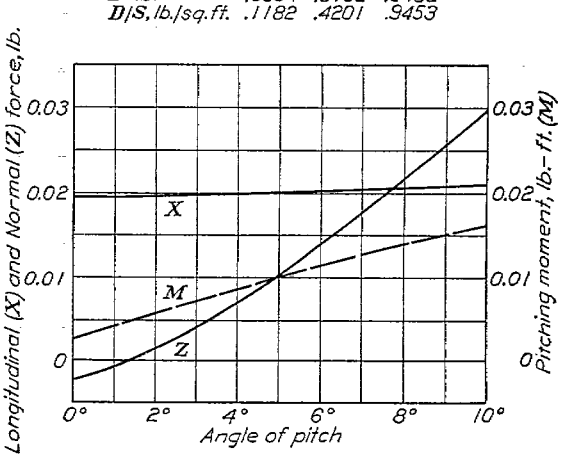
0° pitch and yaw	V, 40 f.p.s.			S=.150 sq. ft.	
Opening	None	A	B	C	D
D, lb.	.0424	.0446	.0461	.0528	.0461
D/S, lb./sq.ft.	.2827	.2973	.3037	.3520	.3073



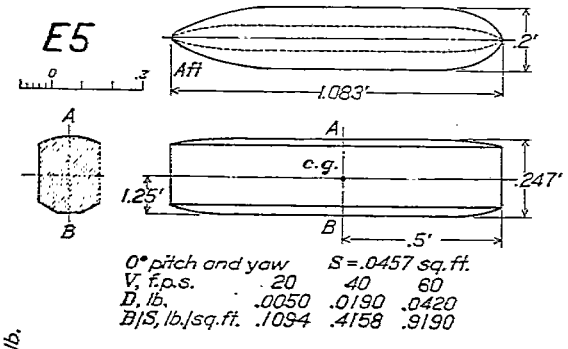
Lift and drag on H. M. A. "Epsilon" airship car. (Ref. R. and M. No. 108)



0° pitch and yaw	S=.0457 sq. ft		
V, f.p.s.	20	40	60
D lb.	.0054	.0192	.0432
D/S, lb./sq.ft.	.1182	.4201	.9453

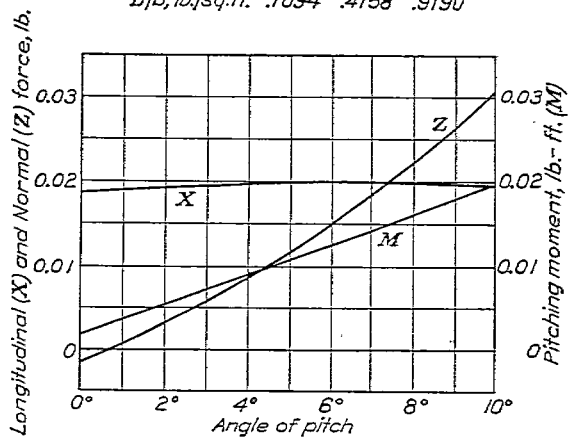


Forces and moments in pitch on airship car "A." (Ref. R. an d M. No. 151)

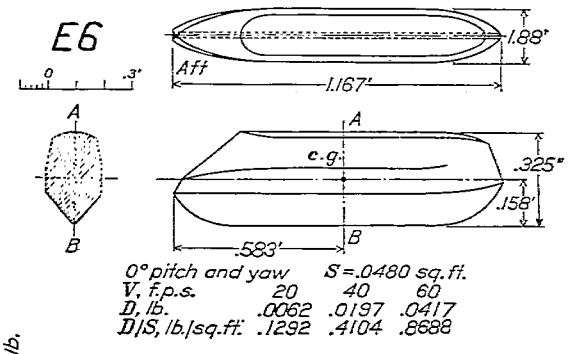


0° pitch and yaw S = .0457 sq. ft.

V, f.p.s.	20	40	60
D, lb.	.0050	.0190	.0420
B/S, lb./sq.ft.	.1094	.4158	.9190

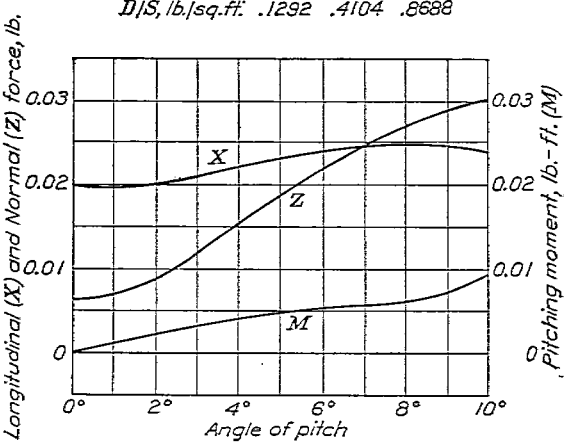


Forces and moments in pitch on airship car "B." (Ref. R. and M. No. 151)

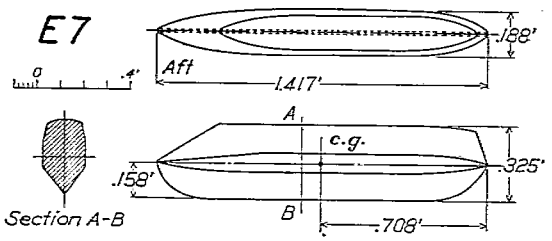


0° pitch and yaw S = .0480 sq. ft.

V, f.p.s.	20	40	60
D, lb.	.0062	.0197	.0417
D/S, lb./sq.ft.	.1292	.4104	.8688

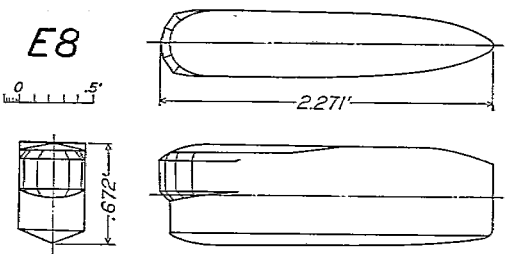


Forces and moments in pitch on airship car "C." (Ref. R. and M. No. 151)



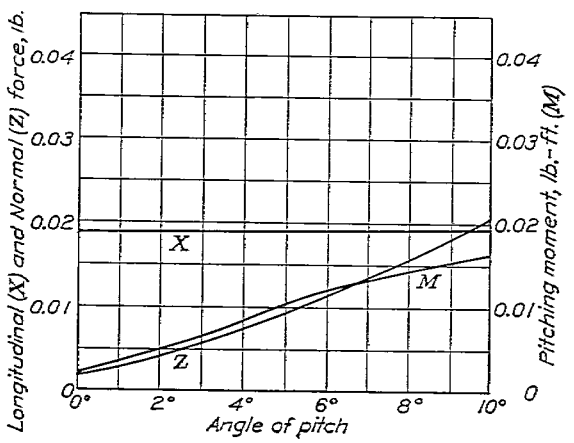
0° pitch and yaw S = .0474 sq. ft.

V, f.p.s.	20	40	60
D, lb.	.0046	.0180	.0393
D/S, lb./sq.ft.	.0970	.3797	.8291

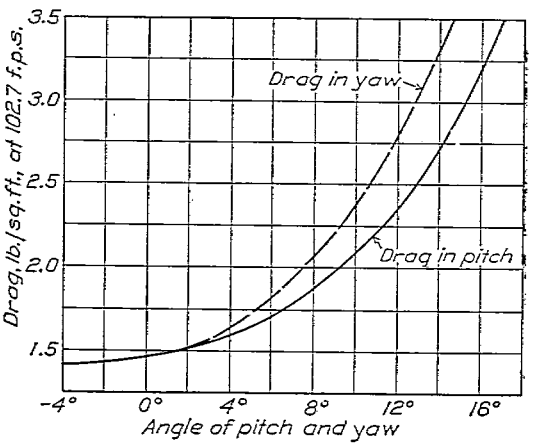


0° pitch and yaw S = .2895 sq. ft.

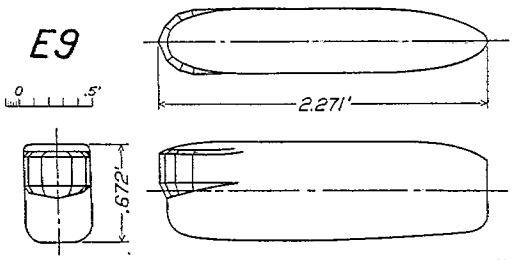
V, f.p.s.	44.0	58.7	73.3	88.0	102.7
D, lb.	.0895	.1520	.2330	.3254	.4305
D/S, lb./sq.ft.	.3092	.5250	.8050	1.1240	1.4870



Forces and moments in pitch on airship car "D." Ref. R. and M. No. 151)

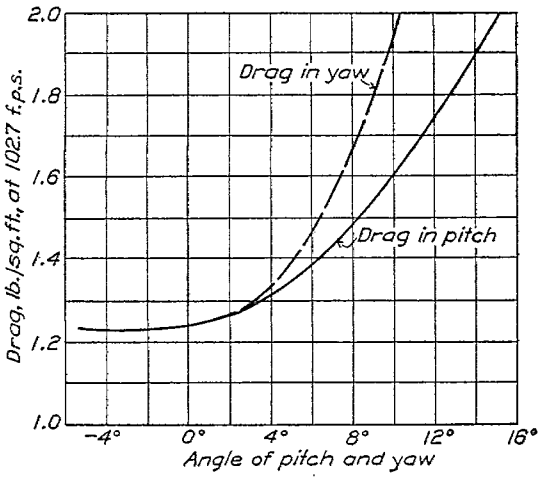


Drag on closed airship car, model No. 326. (Ref. W. T. R. No. 145)

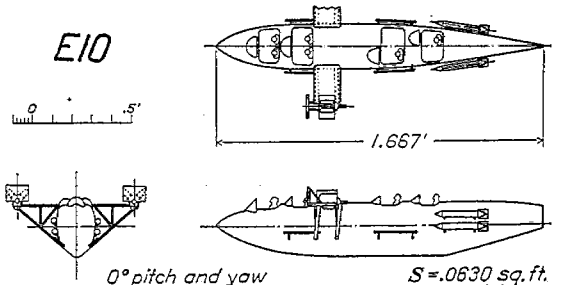


0° pitch and yaw — S = .3034 sq. ft.

V, f.p.s.	44.0	58.7	73.3	88.0	102.7
D, lb.	.0783	.1314	.2005	.2816	.3705
D/S, lb./sq.ft.	.2580	.4330	.6610	.9230	1.2210



Drag on closed airship car, model No. 325. (Ref. W. T. R. No. 145)

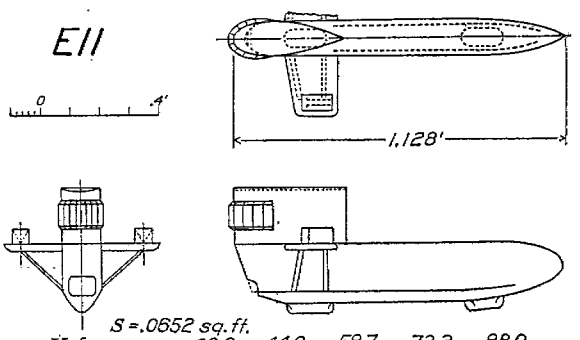


0° pitch and yaw — S = .0630 sq. ft.

V, f.p.s.	29.3	44.0	58.7	73.3	88.0
D, lb.	.0468	.1040	.1835	.2834	.3996
D/S, lb./sq.ft.	.7429	1.6508	1.9127	4.4984	6.3429

Values for model as shown with bombs and appendages

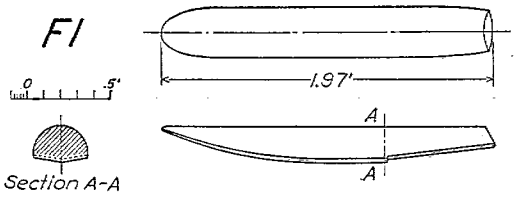
Drag on "C" class car. (Ref. W. T. R. No. 140)



S = .0652 sq. ft.

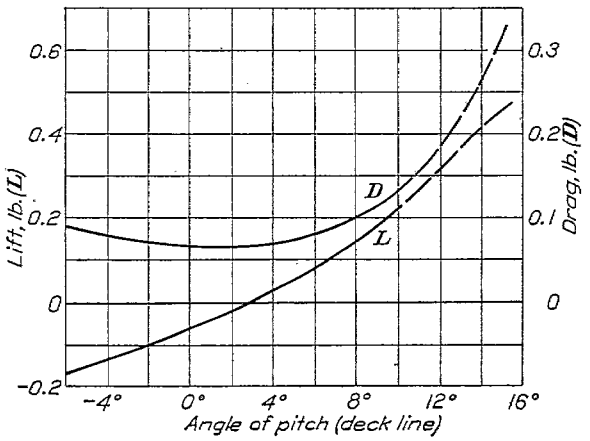
V, f.p.s.	29.3	44.0	58.7	73.3	88.0
D, lb.	.0300	.0636	.1096	.1665	.2313
D/S, lb./sq.ft.	.4601	.9755	1.6810	2.5537	3.5475

Drag on "G" class car. (Ref. W. T. R. No. 140)

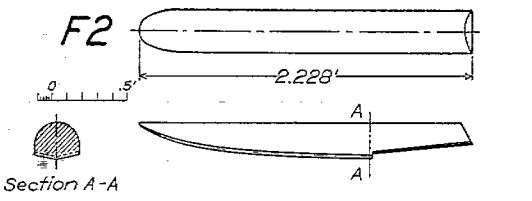


0° pitch and yaw — S = .0751 sq. ft.

V, f.p.s.	44.0	58.7	73.3	88.0
D, lb.	.0366	.0627	.0963	.1390
D/S, lb./sq.ft.	.4874	.8349	1.2823	1.8509

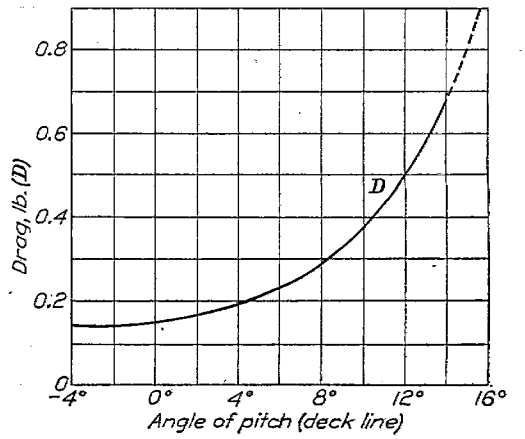


Lift and drag on Speed Scout seaplane float. V=58.7 f. p. s. (Ref. W. T. R. No. 18)

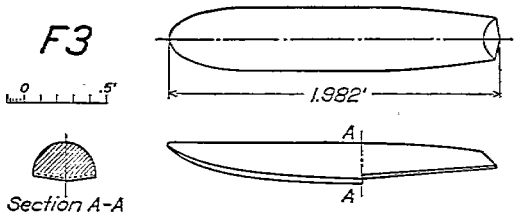


0° pitch and yaw — S = .0554 sq. ft.

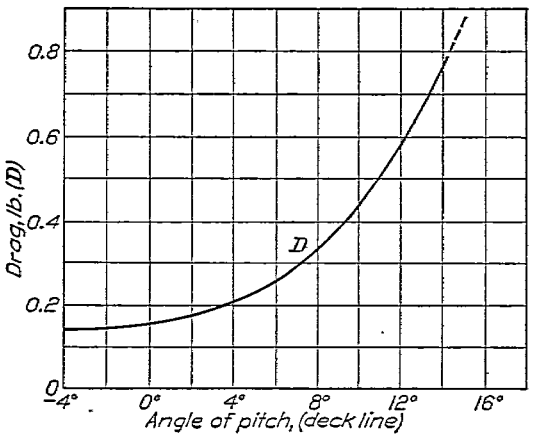
V, f.p.s.	44.0	58.7	73.3	88.0
D, lb.	.0394	.0681	.1063	.1495
D/S, lb./sq.ft.	.7110	1.2270	1.9180	2.6986



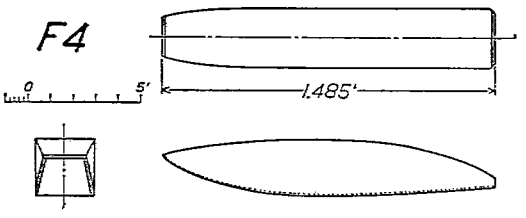
Drag on Speed Scout seaplane float. V=88 f. p. s. (Ref. W. T R. No. 147)



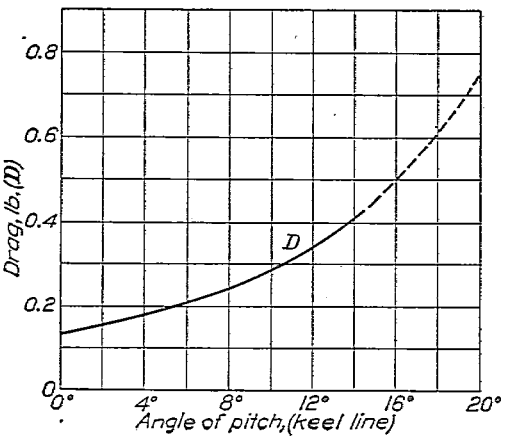
0° pitch and yaw			S=.0751 sq. ft.	
V, f.p.s.	44.0	58.7	73.3	88.0
D, lb.	.0423	.0720	.1129	.1613
D/S, lb./sq.ft.	.5632	.9587	1.5033	2.1478



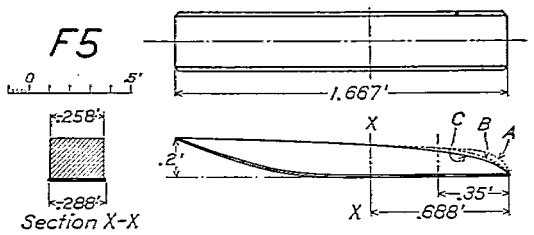
Drag on N-9 seaplane float. V=88 f. p. s. (Ref. W. T. R. No. 147)



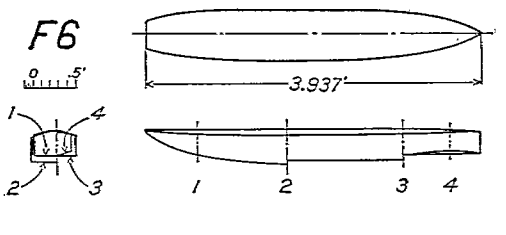
0° pitch and yaw			S=.0729 sq. ft.	
V, f.p.s.	44.0	58.7	73.3	88.0
D, lb.	.0339	.0596	.0923	.1318
D/S, lb./sq.ft.	.4650	.8176	1.2661	1.8080



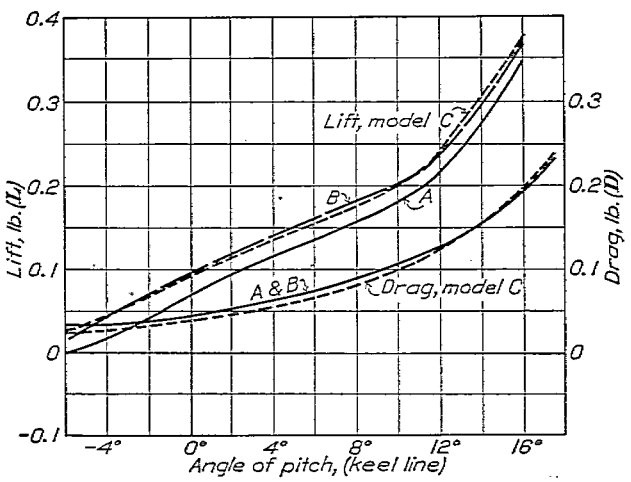
Drag on Sopwith seaplane float. V=88 f. p. s. (Ref. W. T. R. No. 147)



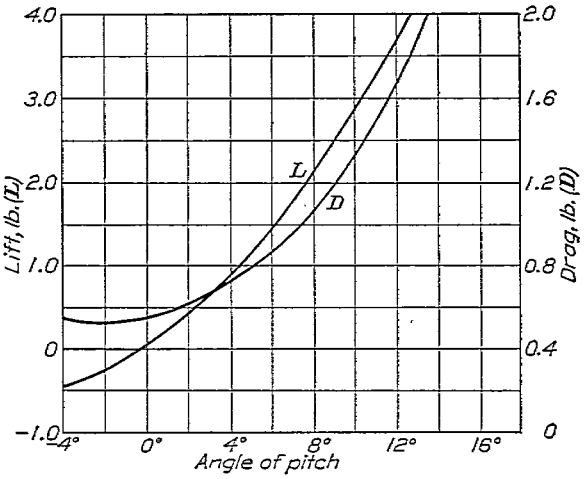
0° pitch and yaw	V=40 f.p.s.		S=.0456 sq. ft.
Model	A	B	C
D, lb.	.0443	.0458	.0406
D/S, lb./sq.ft.	.9715	1.0044	.8904



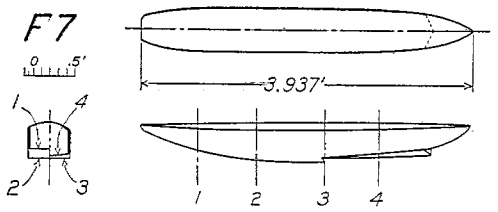
0° pitch and yaw	S=.2326 sq. ft.
V, f.p.s.	98.6
D, lb.	.5560
D/S, lb./sq.ft.	2.39



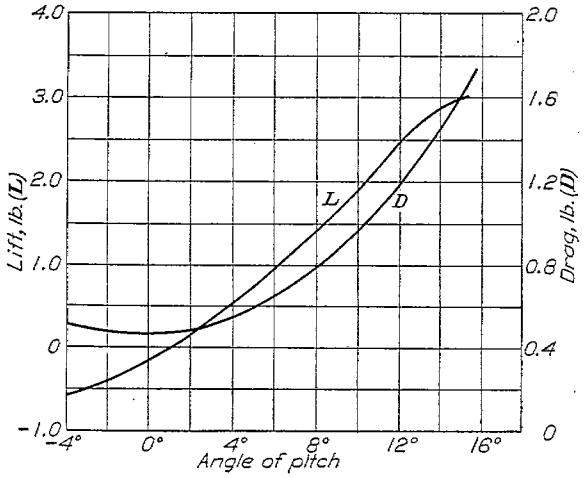
Lift and drag on seaplane float. V=58.7 f. p. s. (R. and M. No. 199)



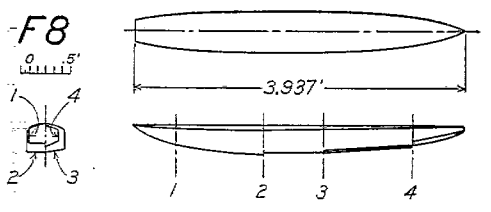
Lift and drag on Göttingen No. 1 float. V=98.6 f. p. s. (Ref. Göttingen 1921)



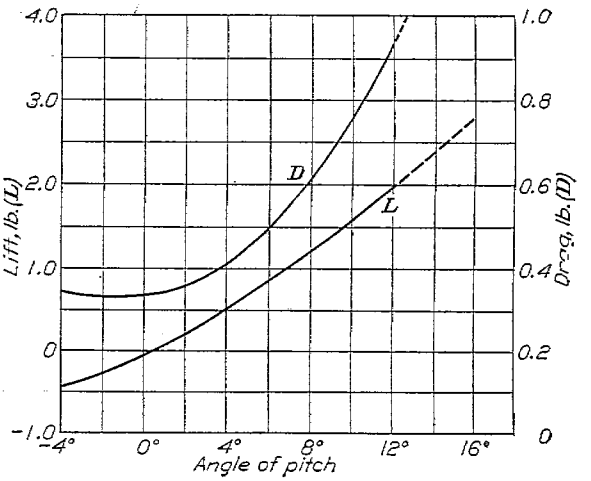
0° pitch and yaw $S = .2160$ sq. ft.
V, f.p.s. 98.6
D, lb. 0.456
D/S, lb./sq. ft. 2.111



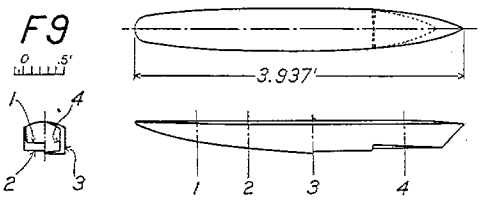
Lift and drag on Göttingen No. 2 float. V=98.6 f. p. s. (Ref. Göttingen 1921)



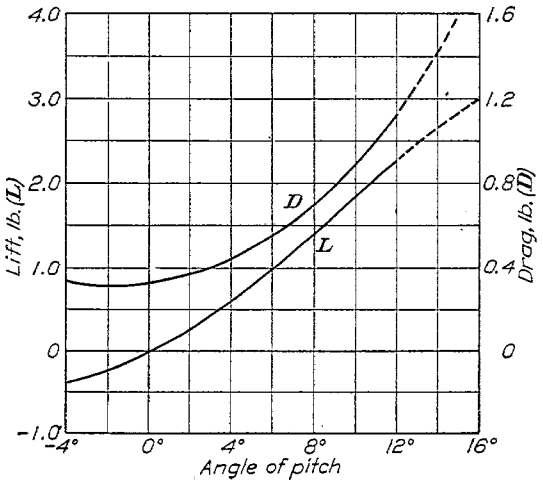
0° pitch and yaw $S = .1525$ sq. ft.
V, f.p.s. 98.6
D, lb. 0.330
D/S, lb./sq. ft. 2.164



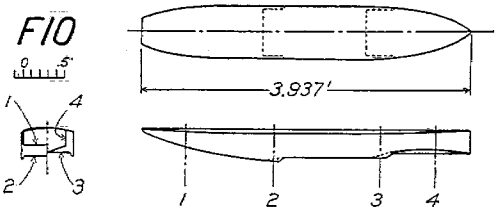
Lift and drag on Göttingen No. 3 float. V=98.6 f. p. s. (Ref. Göttingen 1921)



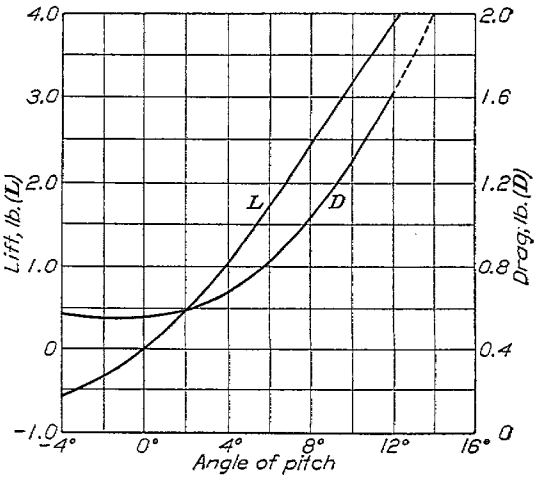
0° pitch and yaw $S = .1940$ sq. ft.
V, f.p.s. 98.6
D, lb. 0.366
D/S, lb./sq. ft. 1.887



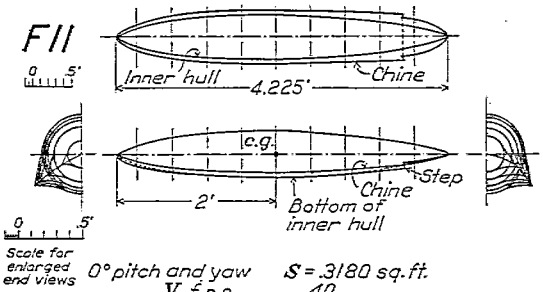
Lift and drag on Göttingen No. 4 float. V=98.6 f. p. s. (Ref. Göttingen 1921)

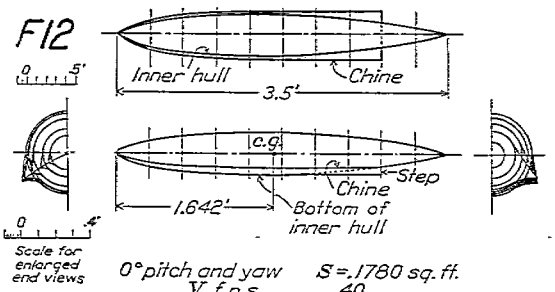


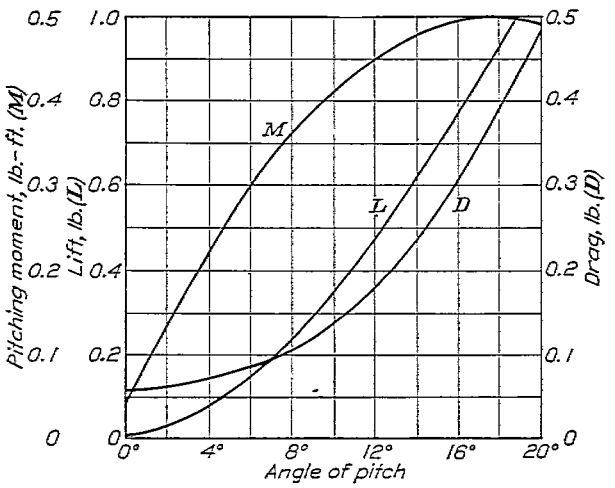
0° pitch and yaw $S = .2255$ sq. ft.
V, f.p.s. 97.5
D, lb. .5520
D/S, lb. sq. ft. 2.45



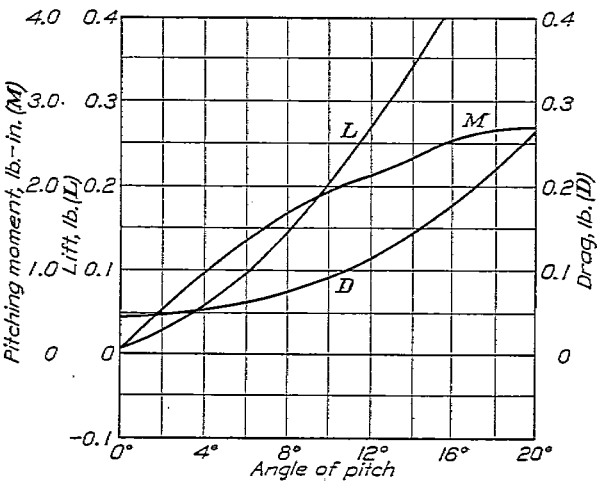
Lift and drag on Göttingen No. 5 float. V=97.5 f. p. s. (Ref. Göttingen 1921)



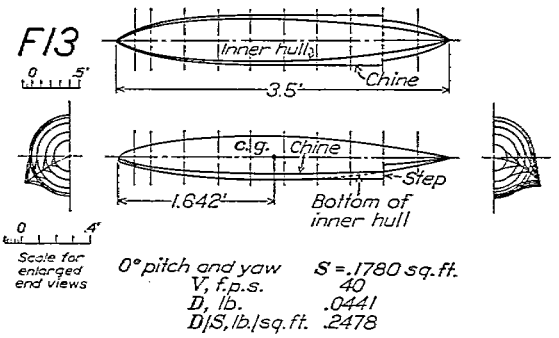


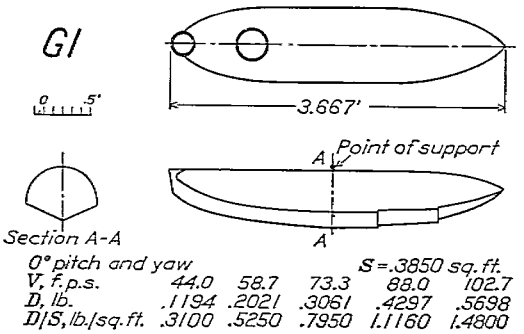


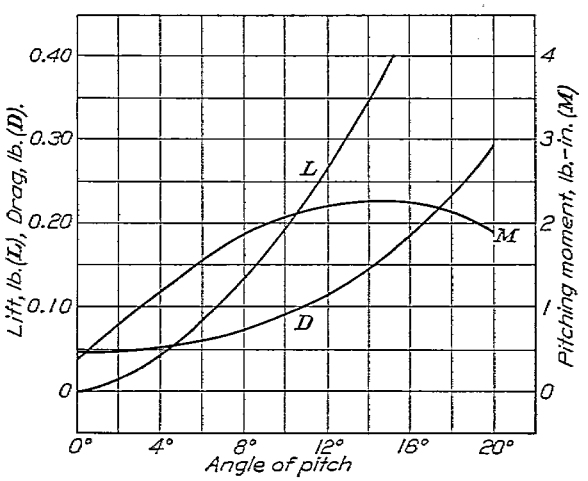
Forces and moments in pitch on an A. D. main float for short seaplanes. V=40 f. p. s. (Ref. R. and M. No. 285)



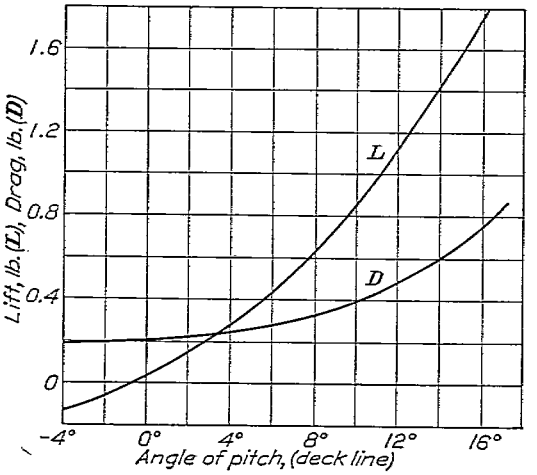
Forces and moments in pitch on a Blackburn seaplane main float No. 2. V=40 f. p. s. (Ref. R. and M. No. 285)



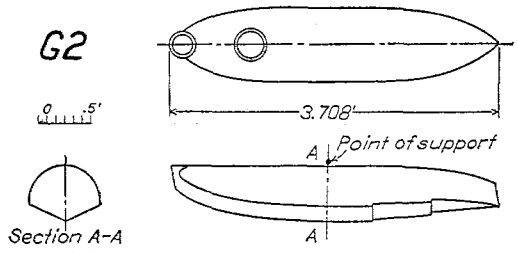




Forces and moments in pitch on a Blackburn seaplane main float No. 1. V=40 f. p. s. (Ref. R. and M. No. 285)

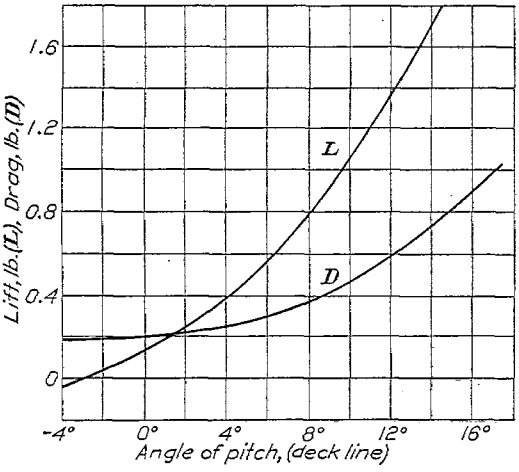


Lift and drag on NC-1 hull, stern No. 1. V=58.7 f. p. s. (Ref. W. T. R. No. 64)

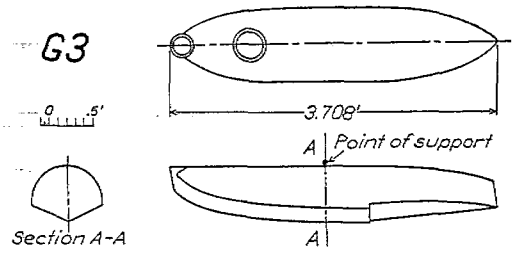


0° pitch and yaw — S = .3850 sq. ft.

V, f.p.s.	44.0	58.7	73.3	88.0	102.7
D, lb.	.1232	.2098	.3099	.4397	.5852
D/S, lb./sq.ft.	.3200	.5450	.8050	1.1420	1.5200

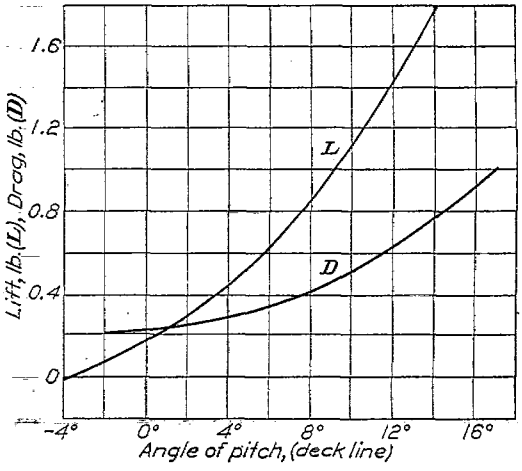


Lift and drag on NC-1 hull, stern No. 2. V=58.7 f. p. s. (Ref. W. T. R. No. 64)

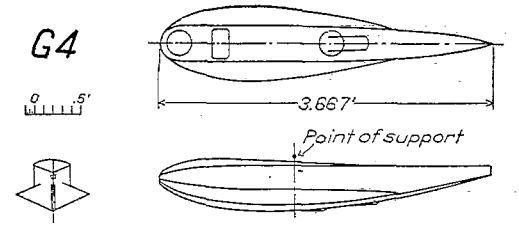


0° pitch and yaw — S = .3850 sq. ft.

V, f.p.s.	44.0	58.7	73.3	88.0	102.7
D, lb.	.1271	.2098	.3165	.4297	.5594
D/S, lb./sq.ft.	.3300	.5450	.8220	1.1160	1.4530

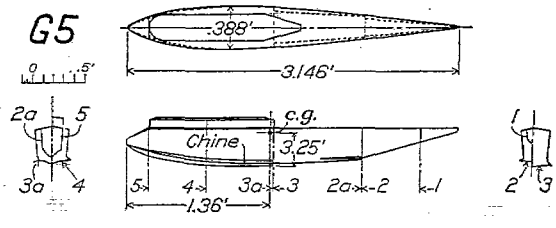


Lift and drag on NC-1 hull, stern No. 3. V=58.7 f. p. s. (Ref. W. T. R. No. 64)



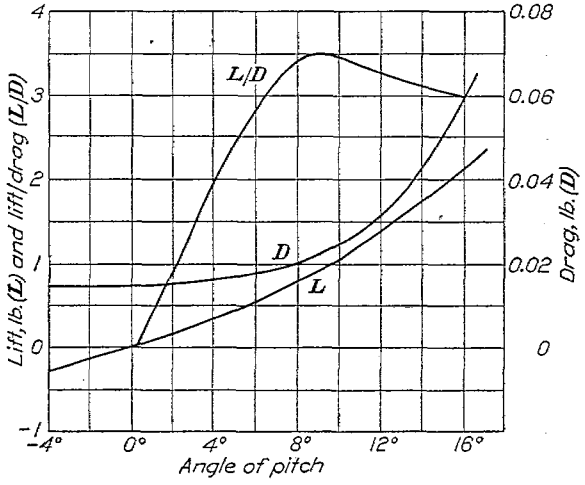
0° pitch and yaw — S = .2720 sq. ft.

V, f.p.s.	58.7	73.3	88.0	102.7
D, lb.	.1190	.1890	.2770	.3800
D/S, lb./sq.ft.	.4370	.6950	1.0184	1.3971

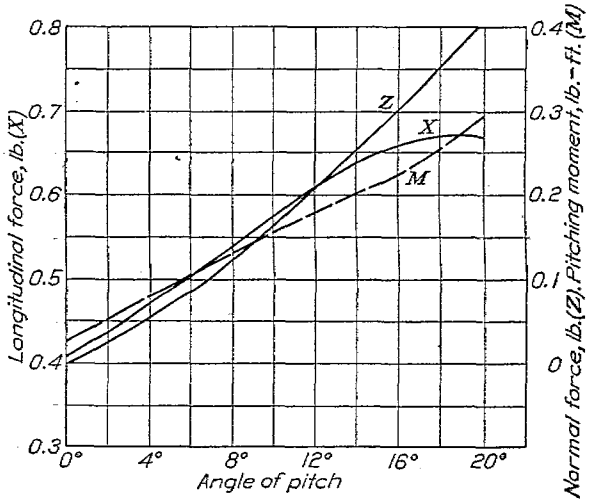


0° pitch and yaw — S = .1400 sq. ft.

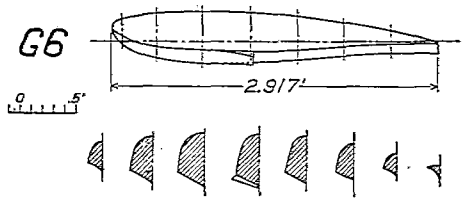
V, f.p.s.	40	50	60	70	80
D, lb.	.0413	.0662	.0953	.1283	.1650
D/S, lb./sq.ft.	.2950	.4730	.6810	.9164	1.1780



Lift and drag on F-5-L seaplane hull. V=58.7 f. p. s. (Ref. W. T. R. No. 83)

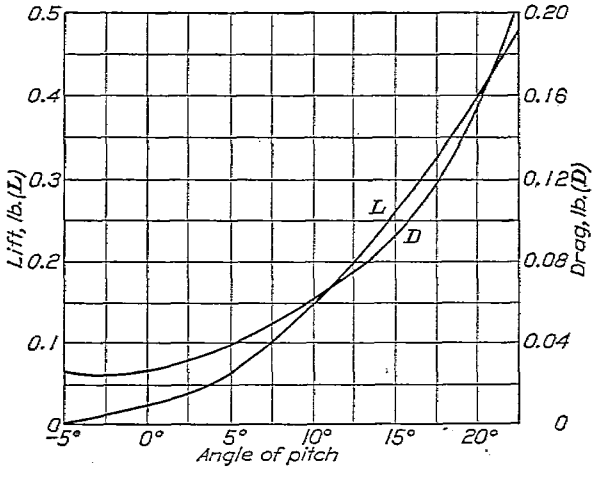


Forces and moments in pitch on hull. V=40 f. p. s. (Ref. R. and M. No. 223)

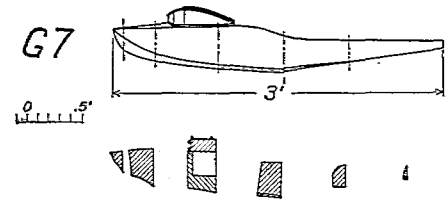


0° pitch and yaw S = .1700 sq. ft.

V, f.p.s.	40	50	60	70	80
D, lb.	.0273	.0445	.0645	.0877	.1130
D/S, lb./sq. ft.	.1606	.2618	.3794	.5159	.6647



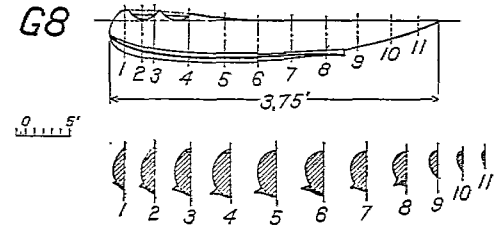
Lift and drag on R. A. E. seaplane hull. V = 40 f. p. s. (Ref. R. and M. No. 461)



0° pitch and yaw

V, f.p.s.	30	40	50	60	70	80
With cabin					S = .257 sq. ft.	
D, lb.	.0428	.0822	.1264	.1810	.2478	.3233
D/S, lb./sq. ft.	.1665	.3198	.4918	.7043	.9642	1.2580
Without cabin					S = .184 sq. ft.	
D, lb.	.0300	.0505	.0775	.1111	.1502	.1976
D/S, lb./sq. ft.	.1630	.2745	.4212	.6038	.8163	1.0739

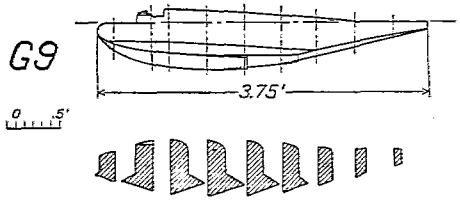
Drag on NT-2B seaplane hull. (Ref. R. and M. No. 461)



0° pitch and yaw S = .186 sq. ft.

V, f.p.s.	30	40	50	60	70	80
D, lb.	.0279	.0475	.0715	.1011	.1381	.1810
D/S, lb. sq. ft.	.1500	.2554	.3844	.5435	.7425	.9731

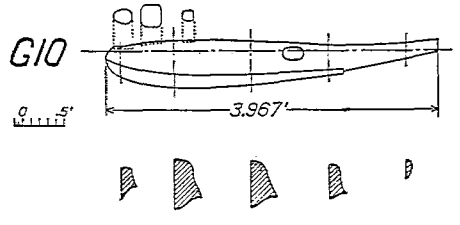
Drag on 30-foot A. D. seaplane hull. (Ref. R. and M. No. 461)



0° pitch and yaw S = .2760 sq. ft.

V, f.p.s.	30	40	50	60	70	80
D, lb.	.0414	.0711	.1108	.1562	.2130	.2695
D/S, lb./sq. ft.	.1500	.2576	.4014	.5659	.7717	.9764

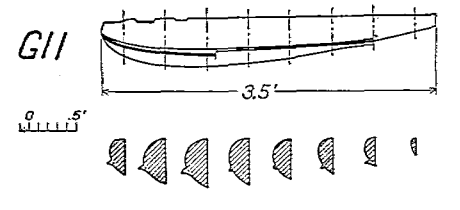
Drag on F-3 seaplane hull. (Ref. R. and M. No. 461)



0° pitch and yaw S = .2520 sq. ft.

V, f.p.s.	30	40	50	60	70	80
D, lb.	.0313	.0532	.0821	.1171	.1591	.2051
D/S, lb./sq. ft.	.1242	.2111	.3258	.4647	.6313	.8139

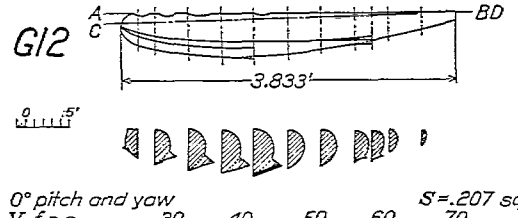
Drag on N-4A seaplane hull. (Ref. R. and M. No. 461)



0° pitch and yaw S = .237 sq. ft.

V, f.p.s.	30	40	50	60	70	80
D, lb.	.0285	.0488	.0750	.1071	.1449	.1880
D/S, lb./sq. ft.	.1203	.2059	.3165	.4519	.6114	.7932

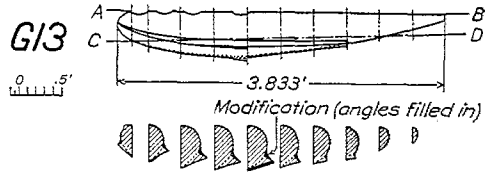
Drag on N-4 seaplane hull. (Ref. R. and M. No. 461)



0° pitch and yaw S = .207 sq. ft.

V, f.p.s.	30	40	50	60	70	80
Line AB parallel to wind						
D, lb.	.0329	.0588	.0903	.1284	.1733	.2253
D/S, lb./sq. ft.	.1589	.2841	.4362	.6203	.8372	1.0884
Line CB parallel to wind						
D, lb.	.0367	.0635	.0978	.1397	.1853	.2420
D/S, lb./sq. ft.	.1773	.3068	.4725	.6749	.8952	1.1691

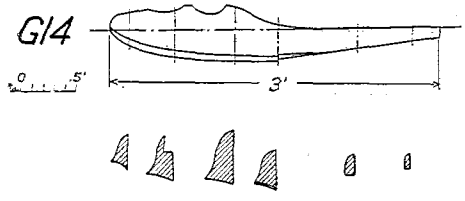
Drag on P-5A seaplane hull. (Ref. R. and M. No. 461)



0° pitch and yaw S = .207 sq. ft.

V, f.p.s.	30	40	50	60	70	80
P-5			Line AB parallel to wind			
D, lb.	.0289	.0492	.0750	.1073	.1420	.1828
D/S, lb./sq.ft.	.1396	.2377	.3623	.5184	.6860	.8831
P-5			Line CD parallel to wind			
D, lb.	.0313	.0549	.0815	.1150	.1566	
D/S, lb./sq.ft.	.1512	.2652	.3937	.5556	.7565	
P-5 (modified)			Line AB parallel to wind			
D, lb.	.0282	.0488	.0750	.1060	.1440	.1840
D/S, lb./sq.ft.	.1362	.2357	.3623	.5121	.6957	.8889
P-5 (modified)			Line CD parallel to wind			
D, lb.	.0292	.0509	.0785	.1130	.1529	.1998
D/S, lb./sq.ft.	.1411	.2459	.3792	.5459	.7386	.9652

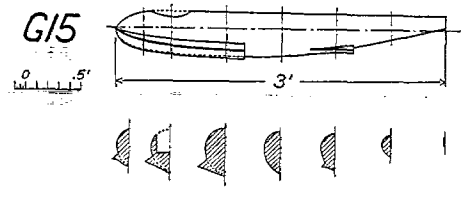
Drag on P-5 and P-5 (modified) seaplane hulls. (Ref. R. and M No. 461)



0° pitch and yaw S = .144 sq. ft.

V, f.p.s.	30	40	50	60	70	80
D, lb.	.2510	.0442	.0691	.0994	.1380	.1768
D/S, lb./sq.ft.	.1743	.3069	.4799	.6903	.9583	1.2278

Drag on NT-T seaplane hull. (Ref. R. & M. No. 461)



0° pitch and yaw S = .139 sq. ft.

V, f.p.s.	30	40	50	60	70	80
D, lb.	.0218	.0372	.0553	.0794	.1070	.1400
D/S, lb./sq.ft.	.1568	.2676	.3978	.5712	.7698	1.0072

Drag on Supermarine N-1B hull. (Ref. R. and M. No. 461)